தமிழ்நாடு உடற்கல்வியியல் மற்றும் விளையாட்டுப் பல்கலைக்கழகம்

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3.4.5 Number of research papers per teacher in the Journals notified on UGC website during the year 2020-2021

S.No	Title of the research paper	Name of the author	Department of teacher	Journal	Year	ISBN
1.	Effect of yogic practices integrated with yoga nidra on mean arterial pressure and heart rate among women with sleep disorder	Dr.S. Selvalakshimi	Department of Yoga	Alochana Chakra Journal	May 2020	2231-3990
2.	Effect of yogic practices integrated with yoga nidra on anxiety and depression among women with sleep disorders	Dr.S. Selvalakshimi	Department of Yoga	Alochana Chakra Journal	April 2020	2231-3990
3.	Overcoming karmic impressions through yogic principles	Dr.S. Selvalakshimi	Department of Yoga	Journal of classical thamizh	December 2020	2321-0737
4.	Effect of the yogic intervention with yoga nidra and trataka on cardiovascular variables among women with sleep disorders	Dr.S. Selvalakshimi	Department of Yoga	Journal of modern Thamizh Research	December 2020	2321-984X
5.	Studies on the effect yogic practices on a psychological and academic related variables of the tobacco	Dr.S. Selvalakshimi	Department of Yoga	Journal of Xidian University	2020-2021	1001-2400

	smoking male students					
6.	Effect of yogic practices integrated with trataka on memory among women with sleep disorders	Dr.S. Selvalakshimi	Department of Yoga	Journal of the Maharaja Sayajirao University of Baroda	2020-2021	0025-0422
7.	Yogic Approach to cope up with perimenopausal symptoms during Covid-19 pandemic	Dr.S. Selvalakshimi	Department of Yoga	Ajanta an international Multi-disciplinary Quarterly Research Journal	December 2020	2277-5730
8.	The effectiveness of yoga on heart rate and hand eye coordination among archery	Dr.S. Selvalakshimi	Department of Yoga	Kala sarvovarQuarterly journal	2021	0975-4520
9.	Spectroscopy analysis for quality control measurement in waste management	Dr.V.Ramesh	Department of Sports Management and Sports Psychology and Sociology	Journal of physics: conference series		
10.	Investigation on aisi 430 ferritic stainless steel weldment by Tig.Mig welding and continuous drive friction welding	Dr.R.Ramakrishnan	Department of Advanced Sports Training and Technology	International Conference on advance in MechanicalEngineering	2020-2021	
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	training among college NCC students					
28.	Efficacy of combination of national cadets corps training and plyometric training on selected physiological variables among college NCC students	Dr.S. Manikandan	Department of Physical Education	Sambodhi UGC care journal	March 2021	2249-6661
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30.	Changes on selected motor components in response to combination of aerobic and anaerobic training among college NCC students	Dr.S. Manikandan	Department of Physical Education	Wesleyan Journal of Research	March 2021	0975-1386
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37.	Prediction of playing ability from selected physiological variables among sports authority of India centre hockey players in southern India	Dr.C.Arumugam	Department of Advanced Sports Training and Technology	Journal of Xidian University	2020	1001-2400
38.	Prediction of playing ability from selected physical fitness variables among sports authority of India centre hockey players in southern India	Dr.C.Arumugam	Department of Advanced Sports Training and Technology	Journal of Xidian University	2020	1001-2400
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	adults					
41.	Efficacy of combination of national cadets corps training and plyometric training on selected physiological variables among college NCC students	Dr.S. Manikandan	Dept. of Physical Education	Sambodhi UGC care journal	March 2021	2249-6661
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26 பகுதி-2
Part -2

OVERCOMING KARMIC IMPRESSIONS THROUGH YOGIC PRINCIPLES

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Abstract

Modern life is often perceived as stressful and it has a negative effect on physical, mental, emotional, and environmental health. The Indian philosophical systems (*shad darshanas*) have classified the types of stress (*dukham*) and they have also provided solutions to overcoming the distress. In order to experience happiness (*sukham*), one needs to understand the mental processes behind actions, and how these reinforced actions become *samskaras.* This article gives an overview of the concepts of *vasanas* and *samskaras*; how they exert their influence on us; and how yoga is an excellent tool in overcoming these karmic impressions.

Keywords: karma, *vasanas*, *samskaras*, Bhagavad Gita, Yoga Sutra of Patanjali

INTRODUCTION

The goal of life is to lead a happy, healthy, and productive life. Every living being has an aversion to unpleasant or unfavourable life events and attachment to favourable life circumstances. Nyaya darshan (one of the six Indian schools of philosophical thought) defines *sukham* (happiness) and *dukham* (misery) as follows (Müller, 1919):

'*Anukoola vedaninam sukham*'.

'When a life situation is favourable to oneself, it is happiness'.

'*Pratikūlataya vedaniyaṁ dukḥam*'.

'When a life situation is against one's wish and will, it is sorrow'.

What modern life has termed as 'stress' depends on whether a person experiences a favourable or an unfavourable life circumstance. Sankhya darshan defines three types of *dukham.*

Aadhibhautik: Caused by other beings

Aadhidaivik: Caused by nature

Aadhyatmik: Caused by oneself (i.e. body and mind)

When these three types of human suffering are analyzed, it can be generalized that the suffering caused by nature (e.g., natural calamities) or by other living creatures is very minimal, especially in modern times where such types of miseries can be avoided, reduced, or remedied through technologies or human effort. A majority of pain in life is *aadhyatmik* or caused by one's own body and mind. Therefore, self-management is key to leading a happy life.

Indian philosophical thought has classified four *purusartha* (goals) in life: dharma (rightful living), artha (rightful prosperity), kama (rightful desires), and moksha (spiritual values). When day-to-day life is charted based on these tenets, a person could lead a balanced and equanimous life. Treading a middle path in all walks of life and maintaining a balanced state of mind is key to happiness. This is also the path of yoga, for Bhagavad Gita (2-48) defines yoga as '*samatvam yoga uchyate*'. To achieve this state of equanimity in life, it is necessary to analyze the actions (karma) and the cause of these actions (desires). Thus, karma is not just physical actions but also the thoughts and desires that lie at the root of that action.

THE DOCTRINE OF KARMA

The word 'karma' needs no introduction to Indians. The word often finds expression in a myriad of positive, negative, or even funny conversation, or it is an ever-present backdrop against which most life's experiences are viewed, judged, or just reminisced. However, most of us do not have an in-depth understanding of karma or how it works. The term 'karma' refers to both an action and the outcome of that action. In other words, karma is both a cause and its effect. According to Deepak Chopra (1996), 'Karma is experience, and experience creates memory, and memory creates imagination and desire, and desire creates karma again'. The whole system – our body, mind, energy and emotions – is programmed because of the impressions that we have taken in.

Figure 1 charts the karmic process and how a latent memory gives rise to an action, the outcome of which further strengthens the initial impressions and shaping the behaviour or personality of a person. For example, a child may desire to taste an unfamiliar sweet based on its look or aroma. Here, the mind desires a pleasurable outcome based on previous impressions and the intellect (buddhi) weighs the pros and cons of fulfilling the desire. Based on the strength of the desire, the child proceeds to eat the sweet and forms a positive or negative experience. If the child found the experience of eating the sweet an exceedingly pleasurable action, this input strengthens the initial impression. With such repeated reinforcements of the pleasurable experience, the child may develop a 'sweet-desiring' behaviour or trait.

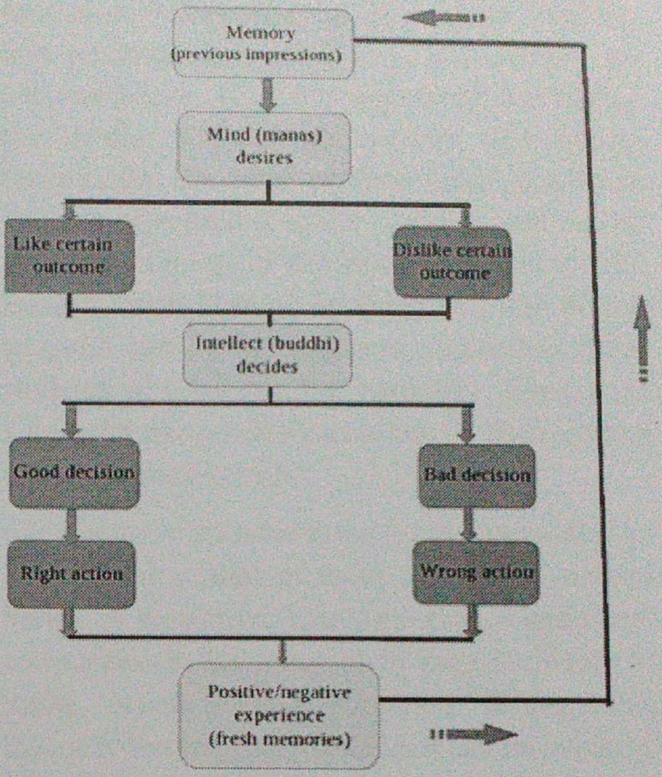

Figure 1: The karmic loop

It is only in recent times that modern science has established that genes are the blueprint by which our entire life is shaped. However, ancient sages and yogic masters have pondered on the underlying factors that drive human existence, and their understanding of human life and what drives it is beyond the grasp of today's scientific established truth. They have explained how our *swadharma* or role in life is determined by our *swabhava* or the expression of *saatva*, *rajo* and *tamo* gunas. The yogic literature classifies karma into three different types:

1. The first type of karma is *sanchita* karma. It is the sum total of karma that is accumulated through various lives and remain as latent impressions or vasanas that await an opportunity for fructification.

2. The second type of karma is *prarabdha* karma. These are the samskaras that are already operating. For example, *prarabdha* karma determines what family one is born into and so on. As this karma is already in action (just as an arrow that has already left the bow and is moving towards a target), it is not possible to overcome this karma. Everyone has to face it.

3. The third type of karma is *kriyamana* or *agami* karma. *Kriyamana* karmas are those that we are creating for the future.

Whatever actions we do create various vasanas and samskaras, and these are accumulated in many different levels of *chitta*, chakras, and life energies.

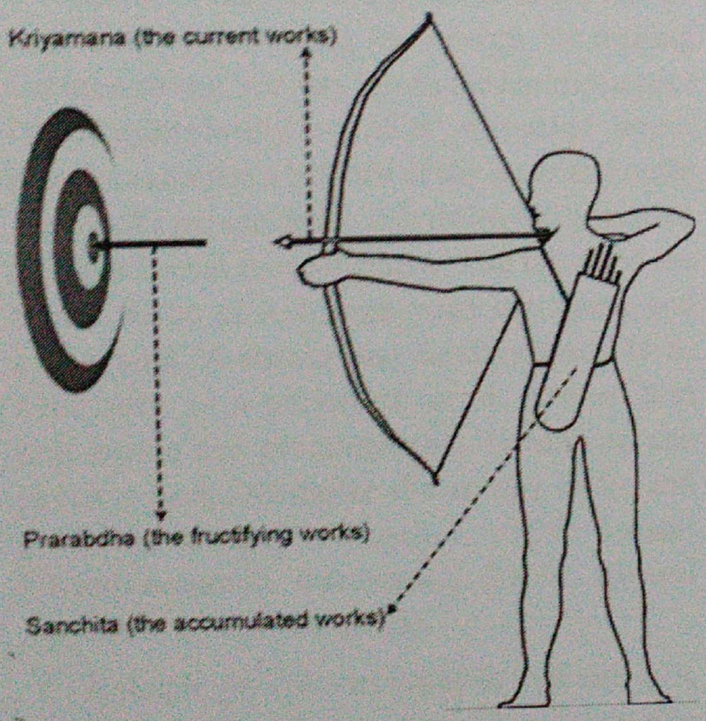

Figure 2: Three karmas depicted through the bowman's analogy

Of these three types of karmas, *prarabdha* karma can be transmuted to our benefit and growth even if the nature of the events or circumstances is not in one's favour. Every life circumstance has a lesson to give, and through self-study one can gain valuable insights that would benefit both the self and the society. For example, when a student fails an exam, he or she can approach the situation in a positive or negative way. The student can become despondent and lose motivation to further the studies. Or the student can analyze the reasons for the poor performance, gain fresh insights or solutions to the problem, and rectify the shortcoming in the upcoming exam. The lessons learnt through hardship can also be put to good use by helping and mentoring other students who face similar hardships. Thus, even a negative *prarabdha* karma can be changed to a positive *agami* karma.

Kriyamana karma is the future potential. The desires and actions of today are the *kriyamana* karma of tomorrow. Everyone craves happiness and success in life. Patanjali in Yoga Sutra (II-16) states, '*heyam dukham anagatam*'. It means that that only future misery (*dukham*) can be avoided. That is, through the necessary study of self and the cause of a problem, future misfortune can be prevented. Therefore, through following the principles of yoga, one can gain mastery over one's actions ('*yogah karmasu kaushalam*', Bhagavad Gita, II-50) and consequentially over one's destiny.

BREAKING THE SHACKLES OF KARMA

Realized masters have said that karmic law, though it functions to a great extent automatically, is also guided by a universal intelligence, and love, and can also be intelligently manipulated or diverted. However, only *sanchita* karma and *agami* karma could be worked out through conscious efforts. In other words, this means that we rewire our thought and energy patterns so that we may rewrite our future in terms of both external success and inward spiritual progress.

The life circumstances of today are to a large extent the result of past desires, decisions, and actions. Most often, the desires and decisions are the result of unconscious conditioned reflexes. Unconscious reflexive actions often lead to unproductive repetitive behaviour. On the other hand, conscious living with an awareness of thoughts and actions will lead to 'right action'. This attitude of witnessing and studying oneself is called as *svadhyaya*. Understanding one's desires in life and aligning them with universal values will produce the 'right action'. The 'right action' not only shapes an exemplary person but also benefits other human beings and society. The Yoga Sutras of Patanjali gives five yamas (restraints) and five niyamas (observances) as a guiding post to lead a rightful life.

Table 1: Moral disciplines of Patanjali

No	Yamas	Niyamas
1	Ahimsa (non-violence)	Saucha (cleanliness)
2	Satya (truthfulness)	Santosha (contentment)
3	Asteya (non-stealing)	Tapas (self-discipline)
4	Brahmacharya (moderation)	Svadhyaya (self-study)
5	Aparigraha (non-hoarding)	Isvara pranidhana (surrender)

Karma is only an energy force and it can be overcome by increasing our energy. By making our aura strong, we may lessen the karmic impact if not completely avoid it. Adopting yogic practices enables a balance of the inner and outer worlds of a person and to live life to full potential, and that's what success means. The third and the fourth limbs of Ashtanga yoga are asana and pranayama. A strong and healthy body is as necessary as a balanced mind. Asanas and pranayama are practices that strengthen the physical body, revitalize the energy body, and calm the mind (Desikachar, 1999; Swami Niranjanananda Saraswati, 2009; Swami Satyananda Saraswati; 2008).

A simple yet a powerful way to shift energy is through affirmations (Swami Satyananda Saraswati, 2009). It was a strong will power that initiated a karma, so an opposite positive affirmation or will power can thwart or balance that energy. If one wants to remove a particular karma, put a strong action in the opposite direction. Sage Patanjali in Yoga Sutra 2:33 terms this as 'pratipaksha bhavana' (Swami Vivekananda, 2019). If things are taken away from you, be more generous and give. This also takes a lot of introspection or svadhyaya.

Every aspect of yoga helps to loosen the grip and shackle of karma, which is the path toward liberation. Karmic impressions are evident in our physical actions and needs, thought patterns, and emotional reactions. One simple way to break the karma physically is to do what you would like to achieve and do it consciously. If one's karma is programmed to wake up at 8 o'clock, then this can be broken by setting the alarm for 5 o'clock. The pre-set body's karma will not want to get up. But one should develop the firm conviction, 'No, I am going to get up'. Thus the old karmic process can be broken by bringing a certain level of awareness to life.

By surrendering the ego through bakthi, seva, and through sadhana, we purify our mind. When an individual mind is purified, the environment is also improved, as the collective karma is nothing but a reflection of the individual karma of the individuals that make up the world. When you do not get attached to the results of your actions, you become free from karma. That is why Lord Krishna says in the *Bhagavad Gita*, 'surrender the results of your actions to Me'. When you wish good for others, good things come back to you. That is the law of nature. The experience of happiness and misery with non-attachment is impotent to produce the seeds of sanchita karma, just as the parched grains are impotent to germinate and produce any crop.

Meditation rectifies painful karma or at least reduces its impact or effect. Meditation brings equanimity and centeredness (Swami Niranjanananda Saraswati, 2006); it helps reduce expectations, your sense of guilt, shame, and a tendency to blame. It brings dispassion and a sense of detachment. Hence as said by Lord Krishna in the *Bhagavad Gita*, even though you act, it does not translate to karma. By loving dispassionately, free from expectations, there is no rebirth and no cycle of karma.

Paramhansa Yogananda (2007) in his book *Karma and Reincarnation* says, 'The more we live guided from within, the greater our control over outer events. For when we live at our own center, in superconsciousness, we live in the only true freedom there is. In soul-consciousness we are no longer helplessly controlled by habits and desires. To the extent that we develop soul-consciousness, we free ourselves from karmic slavery. So meditate daily'. Yogananda further says that every time you meditate some of the karma are resolved. We have seen how people who have adopted meditational practice in their life start to see life transformations or change. In other words, they have broken themselves from this pattern they were on.

The following list encapsulates some of the ways through which past samskaras can be transmuted:

1. Sankalpa (positive affirmations).
2. Svadhyaya (self-study).
3. Following yamas and niyamas.
4. Performing actions with awareness.
5. Enhancing physical culture through asanas and pranayama.
6. Balanced sensual engagement with the worldly desires (pratyahara) or training the sense organs of eyes (seeing), nose (smelling), ears (hearing), tongue (tasting), and skin (feeling).
7. Dharana and dhyana to train the mind to act out our commands rather than us being the slave to the dictates of the mind.
8. Karma yoga or performing actions without expecting the results of those actions.
9. Self-less service to others and society.

To sum it all up, whatever kind of karma one has, it is a limited possibility and that is what makes one into a limited person. So to lead a life with unlimited possibilities one must walk in the yogic path. After all, *for the soul, failure is impossible*.

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சான்றிதழ்

Certificate

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EFFECT OF YOGIC INTERVENTION WITH YOGA NIDRA AND TRATAKA ON CARDIOVASCULAR VARIABLES AMONG WOMEN WITH SLEEP DISORDERS

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ABSTRACT

Sleep disorders are on the rise in India due to work, lifestyle, and social factors. There is a specific need to identify easily accessible complementary therapies to combat the ill-effects of impaired sleep. This investigation assesses the effect of two yoga programs (yogic practices with yoga nidra and yogic practices with trataka) on mean arterial pressure and heart rate in women with sleep disorders. In this study, 45 women aged between 45 and 55 from Chennai, India were screened for sleep disorders based on Sleep–50 questionnaire and were divided randomly into three groups equally. The Experimental Group I practiced yoga integrated with yoga nidra, and Experimental Group II practiced yoga integrated with trataka for 45–60 min for six days a week for 16 weeks. The control group remained in active rest and went about their normal lifestyle. The data on the cardiovascular parameters were collected from all three groups during the baseline and after 16 weeks of yogic intervention. Mean arterial pressure (MAP; mm Hg) was estimated from the blood pressure values measured by a blood pressure monitor, and the heart rate (bpm) was measured by a stethoscope. Analysis of covariance (ANCOVA) was used to determine the significant intergroup difference between the experimental and control groups. Less than 0.05% was set as the significance level. The results of this study show that both yogic approaches (yogic practices integrated with yoga nidra and yogic practices integrated with trataka) significantly decreased MAP and heart rate in women with sleep disorders when compared with the control group. However, there was no significant intergroup difference between the two experimental groups.

Keywords: Yoga, yoga nidra, trataka, sleep disorders, mean arterial pressure (MAP), heart rate

INTRODUCTION

The importance and the essentiality of adequate sleep can be known from the fact that a person spends a third of his/her life in sleep. Industrialization and globalization have brought about immense lifestyle shifts, and one of its consequences is the gradual drop in the hours that humans sleep. Due to increased work pressure, stress, entertainment overindulgence, and social media use, the quality and quantity of sleep has decreased (Walker, 2017; Fulke and Vaughan, 2009). Over time, the sleep deprivation results in developing clinical sleep disorders and other lifestyle and metabolic disorders. Previous studies have established that prolonged sleep deprivation leads to cardiovascular, cognitive, and mental health–related disorders (Sexton-Radek and Graci, 2008).

Scientific evidence shows that sleep deprivation over a period of time increases the susceptibility to lifestyle and metabolic disorders, namely obesity, hypertension, Type-2 diabetes, and mental health disorders (Dia Rekhi, 2019). Chronic sleep deprivation also paves way for the development of sleep disorders. Based on the symptoms, the International Classification of Sleep Disorders (ICSD-3) has classified sleep disorders into the following sections: insomnia, sleep-related breathing disorders, central disorders of hypersomnolence, circadian rhythm sleep-wake disorders, parasomnias, sleep-related movement disorders, and other sleep disorders (Sateia, 2014). Fragmented and unrefreshed sleep has the daytime consequences of physical and mental fatigue; stress, anxiety, and depression; indigestion and constipation; lowered immunity; reduced concentration; and relationship difficulties (Colten and Altevogt, 2006).

Adopting a healthy lifestyle and proper sleep hygiene are essential in the prevention and recovery from sleep disturbance. Studies such as Herur et al. (2010) and Raghul et al. (2018) have proved the effectiveness of yogic intervention in improving sleep parameters and cardiovascular fitness. However, there is a need to study the effect of a set of yogic practices on the problem of sleep disorders as a whole. Through asanas (physical postures), pranayama (regulated breathing), and relaxation practices, yoga brings to balance the body, mind, and emotions. Thus, it has immense potential to prevent and recover from sleep disorders.

PHYSIOLOGICAL RISK FACTORS OF SLEEP: MEAN ARTERIAL PRESSURE (MAP) AND HEART RATE

Sleep is one of the major factors contributing to heart health, and sleep disorders such as insomnia and sleep apnea have been linked with the propensity to develop cardiovascular disease. During sleep, the parasympathetic vagal activity preserves the cardiovascular tone, and modulates the heart rate and blood pressure during the daytime. Chronic sleep deprivation may lead to high blood pressure and cholesterol levels, high body mass index, larger waist size, and coronary heart disease (National Sleep Foundation, n.d.).

Mean arterial pressure measures the average pressure in the arteries over a cardiac cycle. A healthy range of MAP (70–110 mm Hg) is one of the indicators of cardiovascular health, and it ensures blood circulation to tissues and vital organs (Domanski et al. 1999). In this study, the systolic and diastolic blood pressure (SBP and DBP) readings from an electronic blood pressure monitor were converted to MAP values by applying the formula: MAP = 1/3 (SBP – DBP) + DBP.

Heart rate is a predictor of heart health and vagal tone. Specific sleep disorders such as insomnia and sleep apnea increase the sympathetic activity and it increases the heart rate (Nilsson et al., 2001). Previous research (Nilsson et al., 2001; Patra and Telles, 2009; Raghul et al., 2018) have shown the heart rate to be a risk factor of sleep disorders.

PURPOSE OF THE STUDY

The aim of the present study was to find out the effectiveness of two yogic training modules (yogic practices integrated with yoga nidra and yogic practices integrated with trataka) on the selected cardiovascular variables of MAP and heart rate among women with sleep disorders.

HYPOTHESES

The study hypothesized that 16 weeks of yogic practices integrated with yoga nidra (in

Experimental Group I) and trataka (in Experimental Group II) will yield a significant difference in the selected cardiovascular variables of MAP and heart rate among women with sleep disorders, compared with those in the control group.

It was also hypothesized that the two yogic programs (i.e., yogic practices integrated with yoga nidra and yogic practices integrated with trataka) will show a significant difference in the selected risk factors between the Experimental Groups I and II among women with sleep disorders.

REVIEW OF RELATED LITERATURE

Raghul et al. (2018) studied the consequences of overnight sleep deprivation on certain parameters of autonomic function among health care professionals of Mahatma Gandhi Medical College and Research Institute, Puducherry. The study also assessed the modulation of heart rate (HR), blood pressure (BP), and HR variability (HRV) through yogic relaxation (Shavasana). Thirty-five health care professionals of the ages between 20 and 25 years were enlisted from the emergency services wing (casualty) and were taught yogic relaxation (Shavasana). The data on the parameters were noted during the beginning of the day duty, after the end of the night shift (with overnight sleep deprivation), and again after they underwent yogic relaxation. Analysis of the data was done by the student's paired t test to compare the changes after sleep deprivation and then after yogic relaxation. There was a statistically significant ($p < 0.05$) increase in systolic and diastolic BP (SBP/DBP), low frequency (LF), LF/high frequency (HF), and mean HR after overnight sleep deprivation. There were also significant decreases observed in mean RR, SDNN, pNN50, HF, and RMSSD. The data recorded after yogic relaxation show a reversal in the autonomic status. There was a significant decrease in LF, LF/HF, SBP, and DBP, and mean HR, along with a significant increase in mean RR, pNN50, HF, RMSSD, and SDNN. The comparison shows that cardiac autonomic status gets negatively affected by sleep deprivation, and some of this deleterious impact may be recovered by practicing yogic relaxation (Shavasana).

Herur et al. (2010) presented the cardiovascular effects of yoga on healthy participants over 30 years old. Data on blood pressure and heart rate were collected at baseline and after six months of regular yogic practice. A paired t test was used to analyze the data. The results of the cardiovascular variables before and after six months of yogic intervention are as follows: mean resting heart rate (bpm): 77.8 ± 4.8 and 71.3 ± 5.2 ($p < 0.001$); mean resting systolic blood pressure (mm Hg) was 131.4 ± 10.2 and 123.5 ± 9.9 ($p < 0.001$); mean resting diastolic blood pressure (mm Hg) was 85.6 ± 6.8 and 79.6 ± 7.3. A significant reduction was observed at posttest for all the variables. The baseline resting mean arterial pressure (mm Hg) was 100.9 ± 7.3. At the second, fourth, and sixth month of yogic intervention, the mean arterial pressure reduced to highly significant levels of 100.1 ± 7.2 ($p < 0.001$), 96.7 ± 7.3 ($p < 0.001$), and 94.3 ± 7.6 ($p < 0.001$), respectively.

METHODOLOGY

The study enrolled 45 women with sleep disorders screened using Sleep–50 questionnaire from Chennai city. The subjects' ages were between 45 and 55. Experimental random group design was adopted and the selected subjects were randomly divided into three groups equally through simple randomization: Experimental Group I (yogic practices integrated with yoga nidra group; $n = 15$), Experimental Group II (yogic practices integrated with trataka; $n = 15$), and control group (were in active rest; $n = 15$). The two independent variables were (a) yogic practices combined with yoga nidra and (b) yogic practices combined with trataka. The dependent variables were MAP and heart rate. During baseline and after the 16 weeks of yogic intervention, SBP, DBP, and resting heart rate were measured through Omron electronic blood pressure monitor and stethoscope.

The Experimental Groups I and II practiced a sequence of loosening exercises, asanas, pranayama, and mindfulness practice for 16 weeks. There were six sessions a week and each session was about 60 minutes in the mornings. No training was given to the control group. Asanas practiced by the experimental groups were Eka Pada Pranamasana, Surya Namaskar, Kandarasana, Vipareeta Karani, Halasana, Ardha Salabasana, Marjariasana, Paschimottanasana, Ardha Matsyendrasana, Shashankasana, and Shavasana. Pranayama practiced by the experimental groups were Bhramari, Ujjayi, and Nadi Shodhana. The mindfulness practices were yoga nidra for Experimental Group I and trataka for Experimental Group II.

Significant differences between the three groups were calculated through the analysis of covariance (ANCOVA). The chosen level of significance was 0.05%.

RESULTS AND DISCUSSION

Mean arterial pressure

Table I presents the ANCOVA MAP results of the pre-, post- and adjusted posttest mean of the Experimental Group I (yogic practices integrated with yoga nidra), Experimental Group II (yogic practices integrated with Trataka), and the control group.

Table I: Analysis of covariance of MAP

Test	Exp. Gr. I Mean	Exp. Gr. II Mean	Control Group	Source of Variance	Sum of Squares	df	Mean Squares	Obtained F Ratio
Pretest	89.47	88.60	85.73	Between	114.53	2	57.27	1.33
				Within	3190.27	42	75.96	
Posttest	86.53	83.80	92.27	Between	560.13	2	280.07	4.97*
				Within	2369.07	42	56.41	
Adjusted posttest	85.58	83.38	93.64	Between	849.59	2	424.79	15.43*
				Within	1128.84	41	27.53	

*Significant at .05 level of confidence. (The table value for significance at .05 level of confidence for df 2 and 42 is 3.22, and for df 2 and 41 is 3.23.)

The posttest mean values of Experimental Group I and Experimental Group II were 86.53 and 83.80, which has significantly reduced from 89.47 and 88.60. Meanwhile a comparison of the pre- and posttest MAP values of the control group shows an increase after the 16 week study period. The adjusted posttest F value of 15.43 was higher than the table value of 3.23 ($p < .05$). This indicated that 16 weeks of yogic practices has brought forth a significant difference between the three groups on MAP values and satisfies the requirement to conduct Scheffe's post hoc test.

Table II: Scheffe's post hoc test for MAP (in mm Hg)

Adjusted post mean			Mean difference	Required critical value
Exp. Gr. I	Exp. Gr. II	Control Group		
85.58	83.38	–	2.19	4.87
–	83.38	93.64	10.25*	4.87
85.58	–	93.64	8.06*	4.87

***Significant at .05 level of confidence.**

A pairwise comparison between the Experimental Groups and the control group yielded the mean difference of 8.06 and 10.25 ($p < .05$). Since the values are greater than the critical value of 4.87, this indicates that 16 weeks of integrated yogic practices has significantly reduced the MAP values in the Experimental Groups compared with the control group. A comparison between the Experimental Group I and Experimental Group II did not result in a significant mean difference.

The pre-, post- and adjusted mean values of MAP are shown in Figure 1.

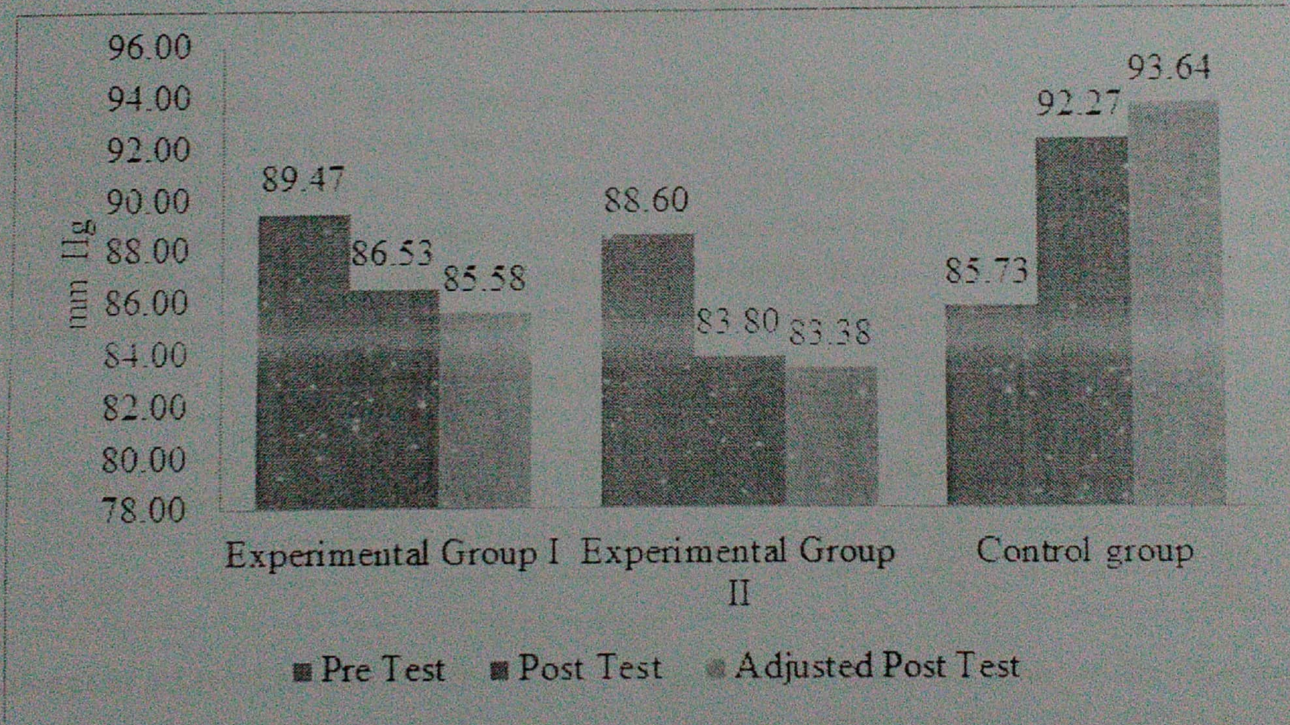

Figure 1: Mean MAP values (mm Hg) of the Experimental Group I, Experimental Group II, and Control Groups

Heart rate

Table III presents the ANCOVA heart rate results of the pre-, post- and adjusted posttest mean of the Experimental Group I (yogic practices integrated with yoga nidra), Experimental Group II (yogic practices integrated with Trataka), and the control group.

Table III: Analysis of covariance of heart rate

Test	Exp. Gr. I	Exp. Gr. II	Control Group	Source of Variance	Sum of Squares	df	Mean Squares	Obtained F Ratio
Pretest	91.73	89.47	90.80	Between	38.93	2	19.47	2.5
				Within	2041.07	42	48.60	
Posttest	83.93	83.67	92.00	Between	672.93	2	336.47	7.37*
				Within	1918.27	42	45.67	
Adjusted posttest	83.16	84.54	91.90	Between	663.04	2	331.52	16.17*
				Within	840.65	41	20.50	

***Significant at .05 level of confidence. (The table value for significance at .05 level of confidence for df 2 and 42 is 3.22, and for df 2 and 41 is 3.23.)**

The posttest heart rate mean values of Experimental Group I and Experimental Group II were 83.93 and 83.67, which has significantly reduced from 91.73 and 89.47. Meanwhile a mean comparison of the pre- and posttest heart rate values of the control group shows an increase after the 16 week study period. The adjusted posttest F value of 7.37 is higher than the table value of 3.23 ($p < .05$). This indicated that 16 weeks of yogic practices has brought forth a significant difference between the three groups on MAP values and satisfies the requirement to conduct Scheffe's post hoc test.

Table IV: Scheffe's post hoc test for heart rate (in bpm)

Adjusted post mean			Mean difference	Required critical value
Exp. Gr. I	Exp. Gr. I	Control Group		
83.16	84.54	–	1.38	4.20
–	84.54	91.90	7.36*	4.20
83.16	–	91.90	8.74*	4.20

***Significant at .05 level of confidence.**

A pairwise comparison between the Experimental Groups and the control group yielded the mean difference of 8.74 and 7.36 ($p < .05$). Since the values are greater than the critical value of 4.20, this indicates that 16 weeks of integrated yogic practices has significantly reduced the heart rate values in the Experimental Groups compared with the control group. A comparison between the Experimental Group I and Experimental Group II did not result in a significant mean difference.

The pre-, post- and adjusted mean values of heart rate are shown in Figure 2.

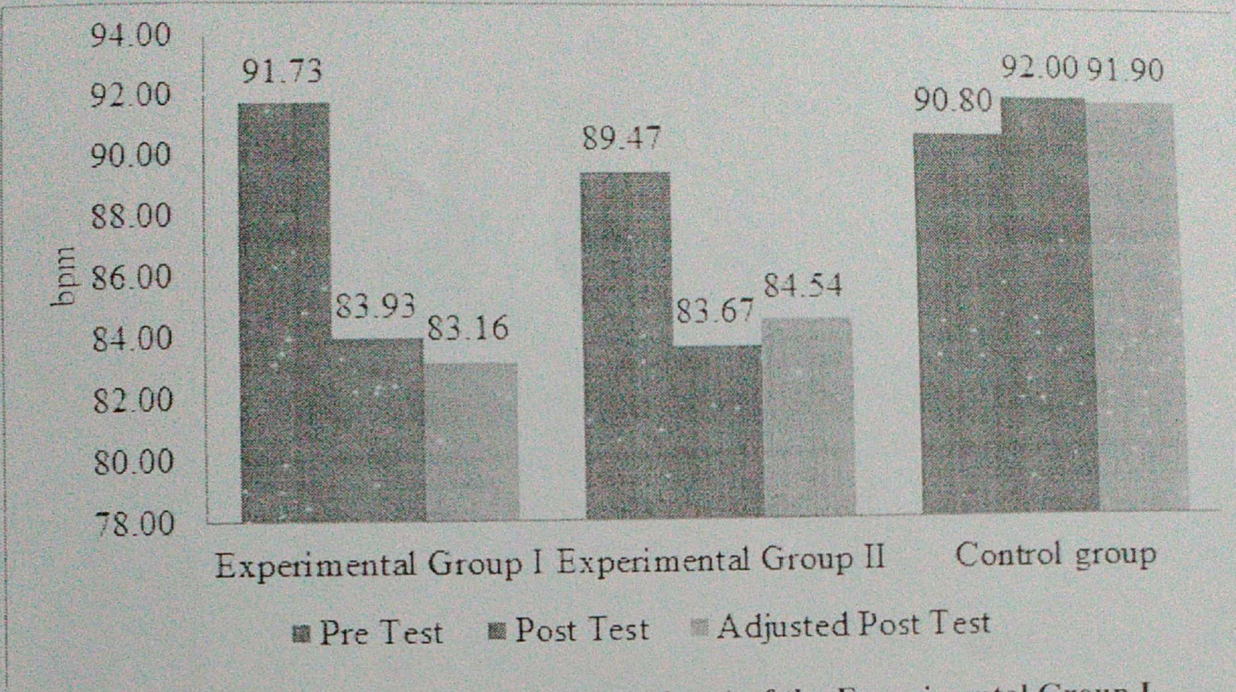

Figure 2: Mean heart rate values (in bpm) of the Experimental Group I, Experimental Group II, and Control Groups

CONCLUSION

ANCOVA and Scheffe post hoc test results reveal a significant reduction in the MAP and heart rate after undergoing 16 weeks of either (a) yogic practices integrated with yoga nidra or (b) yogic practices integrated with trataka, compared with the control group. There was no significant difference between the two experimental groups, suggesting that both yogic programs had an equally positive effect on MAP and heart rate. The outcomes on the cardiovascular variables of this study are similar to those of the Raghul et al. (2018) and Herur et al. (2010), taking into consideration the difference in the study population. Sleep disorders have a negative impact on the cardiovascular system, and the study outcomes suggest that yogic practices may prevent and reduce the cardiovascular risk factors among women suffering from sleep disorders.

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STUDIES ON THE EFFECT OF YOGIC PRACTICES ON A PSYCHOLOGICAL AND ACADEMIC-RELATED VARIABLE OF THE TOBACCO SMOKING MALE STUDENTS

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Abstract

The current study attempted to explore the impact of yogic practices on tobacco smoking male students. Thirty numbers of students from the different engineering colleges in the age group of 18-22 are randomly selected as a sample. Pre-test, post-test random group design is followed in the sample by branched into the experimental group (15 Nos.) and control group (15 Nos.). The impact of yogic practices after twelve weeks is tested on the selected (i) psychological variables viz., perception about the smoking habit and the ability to quit the cigarette smoking and (ii) studies related variable, i.e., Academic performance. The pre-test scores and post-test scores are statistically analyzed for the test of significance using Analysis of Variance (ANOVA). It is concluded from the results of the current study that the yogic practices are proved its ability to enhance the possibilities to quit smoking habits and improves their academic performance.

Keywords: Tobacco smoking, yogic practices, quit smoking, academic performance, statics design

I. INTRODUCTION

The definition given by the World Health Organization (WHO) about health is "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity." If a person can balance the physical, mental and social challenges during the life span, then it is believed that he is healthy [1].

Cigarettes are an item devoured through smoking and fabricated out of relieved and finely cut tobacco leaves and reconstituted tobacco, regularly joined with different added substances, which are then folded or stuffed into a paper-wrapped chamber. Cigarettes are lighted and breathed in, as a rule through a cellulose acetic acid derivation channel, into the mouth and lungs. Cigarette smoking is a sequence of actions viz., burning the tobacco and inhaling the solid smoke particles dispersed in the gas medium. [2].

Tobacco smoke conveys over 4000 chemicals. 250 of these are known to be hurtful. Furthermore, more than 50 are known to cause malignant growth. As indicated by a reality sheet distributed by WHO, tobacco executes about 6 million individuals consistently. Above 5 million of these passing is the consequence of direct tobacco use. Nearly 6,00,000 non-smokers are died because of inhaling the second-hand cigarette smoke [3].

The smoking habit begins in many lives during their school or college period. It makes them feel pleasure combined with suppressing stress, relaxation though they experience adverse symptoms like cough, nausea as a beginner. Over a period, the neglect of withdrawal symptoms, social-status and peer pressure makes the smokers proceed with this habit. From the research finding, it is observed that the advertisements related to cigarette smoking, movies, smoking by parents, friends are acted as the driving force for the students to experience the same. And while smoking can thrill in the beginning, its charm fades in a while. In no time at all, many health problems insidiously creep in. And then the smoker ends up wanting to shake off the habit. Smoking gives temporary happiness and leads to misery and pain [4].

Cigarette smoking is the primary source of preventable demise and significant general well-being concerns. Tobacco use leads most usually to ailments influencing the heart and lungs, with smoking being a significant hazard factor for coronary episodes, strokes, ceaseless obstructive pneumonic infection (COPD), Idiopathic Pulmonary Fibrosis (IPF), emphysema, and cancer. Dependence on nicotine causes premature aging and a host of other pressing issues [5].

Yoga is a gathering of physical, mental, and profound practices or trains which began in ancient India. Yoga advises us to do a specific practice and afterward to feel the impact of that training. Yoga is a science of awareness. The reasons for the addiction to smoking may be sheer enjoyment, fashion, peer pressure, stress, or any other such root factors. To solve the problem, the identification of the reason is mandatory [6].

It is suggested to follow any of the three steps given to quit an addiction viz., fear of disease, greed and love. Without the co-operation of the user, it's highly complicated to come out of an addiction. It is essential to create awareness about how to harm the habit is to the well-being. Yoga plays a vital role in solving the withdrawal symptoms [7].

Along with the rehabilitation treatment, Yoga gives a supportive mechanism to get out of the smoking habit. It helps to reduce stress, stimulates hormones, middles area of the brain, increases energy and stamina, eliminates toxins and helps to control the cravings. The improvement in the overall well-being, immune system, lung capacity, blood circulation, heart rate, attainment of full energy, calmness in mind and vitality are gained through the surrender of the smoking habit. Con-currently the causes for the cancer are also reduced [8].

Studies have been attempted to examine the smoking frequency among current college student smokers, factors related to readiness to quit smoking [9], smoking habits and attitudes among university students in Palestine [10], factors associated with smoking behavior [11], characteristics of social smoking among college students [12] by researchers.

An experiment has been made to notice the effect of Yoga (i) on academic performance concerning stress [13], (ii) on relaxation among college students with high stress [14] and (iii) on immune responses in examination stress [15].

The objective of the current study is to inspect the effect of yogic practices on selected psychological variables (perception about the smoking, ability to quit smoking) studies related variable (Academic performance) among the cigarette smoking male students of age group 18-22 using Global youth tobacco survey. The pre-test, post-test outcomes are statically analyzed using ANOVA. The workflow of the current study is given in Fig.1 [16].

The delimitations of the currents study are summarized as (i) male smokers of age group 18-22 (ii) samples are selected from engineering colleges located in Chengelpet district (iii) 12 weeks of yogic practices, Six days per week and one hour per day (iv) 15 numbers of samples in the control group and experimental group each (v) independent variable is yogic practices and (vi) dependent variables are psychological variables and academic performance. The limitations of the studies are neglect of the socio-economic status, life-style, body structure, personal habit, routine work, medication and family hereditary of the samples.

II. MATERIALS AND METHODS

2.1. Sample

For the current study, thirty numbers of male students with tobacco smoking habits are selected from different Engineering colleges located in Chengelpet district at random. The samples are with the age group of 18-22 years. They are made into two groups, namely the control group and the experimental group, with 15 numbers in each.

2.2. Variables selection

The selection of variables is based on the literature and feasibility criteria.

Dependent variables

Perception about the smoking habit and the ability to quit tobacco smoking are selected as Psychological variables and the academic performance of the students is taken as a study-related variable.

Independent variables

Yogic practices, including loosening exercises, Suryanamaskar, Asanas, Pranayama and Mudra, are considered as an independent variable.

2.3. Experimental design

The experimental group of fifteen students underwent yogic practices for twelve weeks. Pre-test, post-test random group design is followed in this study. They practiced Yoga during evening sessions between 5.00 to 6.00 am daily except Sunday, warming-up and loosening express are given before starting a yoga practice. The intensity of yogic practice is increased every week by increasing the number of asanas, Yoga Nidra and repetition.

2.4. Reliability data

The reliability of the data is established before initiating the experiment. For this purpose, 15 engineering college students of 18-22 age groups are enrolled. To ensure reliability, test and retest method is followed. All the dependent variables tested for all the 15 students using the same testing methodology under similar are conditions. The scores are tested to ensure reliability. All the criterion variables are significant at the 0.01 level. It is implied that all the test items are reliable.

2.5. Schedules for yogic practices

The yogic practices include the Loosening exercise, Suryanamaskar - Bihar school of Yoga, Asanas viz., Trikonasana, Sarvangasana, Sethu bandhasana, Bhujangasana, Shishuasana, Marjaryasana/Bitilasana, Dhanurasana and Savasana. Pranayama includes Yogendra Pranayama, Kapal Bhati Pranayama, Nadi Shodhan Pranayama and Kaleshwar mudra is also practiced [17, 18].

All the planned asanas could help ex-smokers avoid cigarettes. One of the foundations of Yoga is the guideline of breathing, and that is the reason it's an incredible instrument for ex-smokers to surrender the propensity for good. Yoga presents include stomach or diaphragmatic breathing, or shallow breathing through thoracic and clavicular techniques. These connect with the whole oxygen channel and give improved gracefully of blood and oxygen to vital organs, which keeps them restored [19].

2.6. Test Administration

2.6.1. Psychological variables

Purpose: To find out the perception about the smoking habit and the ability to quit cigarette smoking.

Method: Global youth tobacco survey (GYTS) [10].

Procedure: The Questionnaire is distributed in a group setting. The meaning and procedure are explained and made the subjects to select the appropriate answer.

Scoring: The Questionnaire contains 20 questions; each consists of 2-4 responses. The students are asked to select only one option. The maximum score is 50. The score for each option varies.

2.6.2. Study-related variable

Academic performance

Purpose: To find out the academic performance of the cigarette smoking student before and after the treatment.

Method: Conventional exam pattern and manual correction.

Procedure: Class tests are conducted in the subject named "Numerical methods" for all the 30 students of the control group and experimental group before and after the treatment.

Scoring: The Question paper subsists of (i) ten number of Multiple-choice questions, (ii) four number of short answers each carries 4 marks and (iii) two number of detailed answers each brings 12 marks. The maximum grade is fixed as 50. The answer scripts are evaluated manually.

2.7. Collection of data

The study's goal is to audit the effect of yogic practices on selected psychological variables and study-related variables among the samples. The investigator collected the original scores before the experiment from both groups as the procedure mentioned in the test administration. After the experimental period, final test scores are collected on the criterion variable.

2.8. Statistical technique

The data collected from the subjects are treated statistically. The convincing difference among the results of the control group and the experimental group are examined by Analysis of variance (ANOVA).

The level of significance is fixed as 0.05 level. The standard statistical package is used to analyze the data.

III. RESULTS AND DISCUSSIONS

3.1. Test of significance

This system of testing the hypothesis is finished by tolerating the theory or dismissing the equivalent as per the outcomes corresponding to the level of confidence fixed at 0.05. In the event that the got esteem is more noteworthy than the table worth, the theory acknowledges that there existed massive contrast among the methods for the gatherings analyzed and if they got qualities are lesser than there is no considerable distinction between the methods. The likelihood level underneath which the hypothesis is dismissed is named as the level of significance.

3.2. Psychological variable

The raw scores of the Global Youth Tobacco Survey of the control group and the experimental group (pre-test, post-test) are used for comparative studies. The statistical analysis comparing the initial and final (after twelve weeks) scores of the control and experimental groups is discussed. The total scores earned in the GYTS by the control group (Fig.2) and the experimental group (Fig.3) before and after the treatment are compared. The pre-test, post-test mean value of each group is compared in Fig. 4.

The mean value of the control-initial group and the final group are 7.4 and 8, respectively. The significance value is 0.566 (i.e., $p = 0.566$), which is above 0.05 and, therefore, there is a statistically no significant difference in the psychological behavior among the control group (Table 1). At the confidence level of 95%, the lower and upper bound lies between 3 and 11 for the first score, 3 and 16 for the final score in the case of the control group (Table 2).

In the case of the experimental group, the p-value is 6.65x10-22, which is below 0.05 and, therefore, concludes that there is a statistically significant difference in the psychological behavior among the experimental group before and after the yogic practice (Table 3).

Table 3 and 4 clearly indicates the betterment in the experimental group when the yogic practices are taken. The mean score of the raw data significantly boosted from 12.7 to 43. The lower and upper bound at the 95% level of confidence is hiked from 7-19 and 36-46 before and after the yogic practices. The smaller standard error value confirms that the sample mean closer enough with the population means and there is a less spread.

Standard deviation is calculated in order to interpret the spread out a data. The excellent standard deviation is confirmed through the value of the coefficient of variation (CV), which is the ratio between standard deviation and mean. The less than 1 value of CV denotes that the data are distributed around mean, which is expected.

The results are acknowledged that the yogic practices uplift the mood to quit smoking and enable them to think about the impact of smoking on health. Akin results have been noticed in the study carried out among the first-year MBBS students. There is a highly significant difference in physiological parameters in the experimental group who practiced Yoga for 12 weeks [15, 20].

3.3. Study-related variable

The academic performance of the control group and experimental groups are evaluated by conducting the exam. For the engineering college students irrespective of the discipline, a subject named "Numerical methods" is standard. The reasons for the selection of this subject are it involves (i) a lot of concentration (ii) memorization of formulas and rules and (iii) regular practice. To confirm the uniformity in the mode of conducting the exam, a common subject "Numerical methods" is selected.

Though the control group is not given yogic practices, along with the experimental group they have also participated in the exam both initially and at the end of the twelfth week. The pre-test, post-test scores of the control group and the experimental group, are given in figures 5 and 6.

From the figure, it is clearly understood that there is a notable difference in the academic performance of the experimental group after the completion of twelve-week yogic practices. To perform well in the subject like mathematics, it is mandatory to have concentration, memory power and orientation. The results indicate that the prescribed yogic practices could boosted-up all these qualities.

The mean of the academic performance of the control group is calculated as 25.7 (pre-test) and 26.8 (post-test). It is found as no significant difference among them (Table 5-6). Similarly, the academic performance means of the experimental group before and after the yogic treatment is calculated (27.67, 38.27) (Table 7-8) and shown in figure 7. The difference is excellent for the sample size of 15. The sum of the scores of all the 15 in the experimental group is raised from 418 (pre-test) to 574 (post-test) out of 750. The improvement is expanded from 55.7% to 76.53%, which is a notable change during these 12 weeks. To weigh the lack of symmetry of data, Skewness is detected and the value of Kurtosis expresses the resemblance of the data either heavy-tailed or light-tailed proportionate to a normal distribution.

Variables	**Research Hypothesis**	**Null Hypothesis**
Psychological variable	Accepted	Rejected
Study-related variable	Accepted	Rejected

It is found in the present study that for the experimental group, the perception about the smoking habit, ability to quit cigarette smoking and academic performance have reduced significantly due to the regular practice of Yoga, pranayama and mudra. Similar results are identified in work tested on the effects of Marijuana smoking among secondary school students on academic performance [21, 22]. It is hypothesized that the changes in psychological variables and study-related variables would differ significantly for the experimental group when compared to the control group due to yogic practice.

IV. CONCLUSIONS

The 12-weeks yogic practices are framed with the combination of loosening exercises, Surya Namaskar, asanas, pranayama and mudra to target the male students of age group 18-22 with the tobacco cigarette smoking habit. The students are segregated into a control group (15 Nos.) and experimental group (15 Nos.). Impact of yogic practices after the 12-week program is evaluated through (i) psychological variable (perception about the smoking, ability to quit smoking) using Global youth tobacco survey (GYTS) and (ii) selected study-related variable (Academic performance). Pre-test. Post-test random group design is followed in this study. The obtained data are statistically analyzed for the test of significance using analysis of variance (ANOVA). In all cases, the significant level fixed is 0.05 level, which is considered as appropriate. Improvement in their academic performance indicated their improvement in concentration, memory and orientation. The results of the control group of similar categories have not shown any significant difference between pre-test and post-test.

The outcomes demonstrated that Yoga, even only the short term, is a compelling methodology and steady instrument to deliver the smokers to dispose of the dependence. Moreover, long haul follow-up may give understanding to the exhibition of understudies. In outline, a yoga mediation indicated good results on the smokers both mentally and scholastically. Yet, the current examination should have been fortified or upheld by progressively important research contemplates.

The findings of this study would be helpful for physiotherapists, trainers to demonstrate the yogic practices in the overall development of the students and get relief from the influence of cigarette smoking. It provides knowledge on the systematic approach of yogic practices on smokers and further motivates the researcher to work on related variables.

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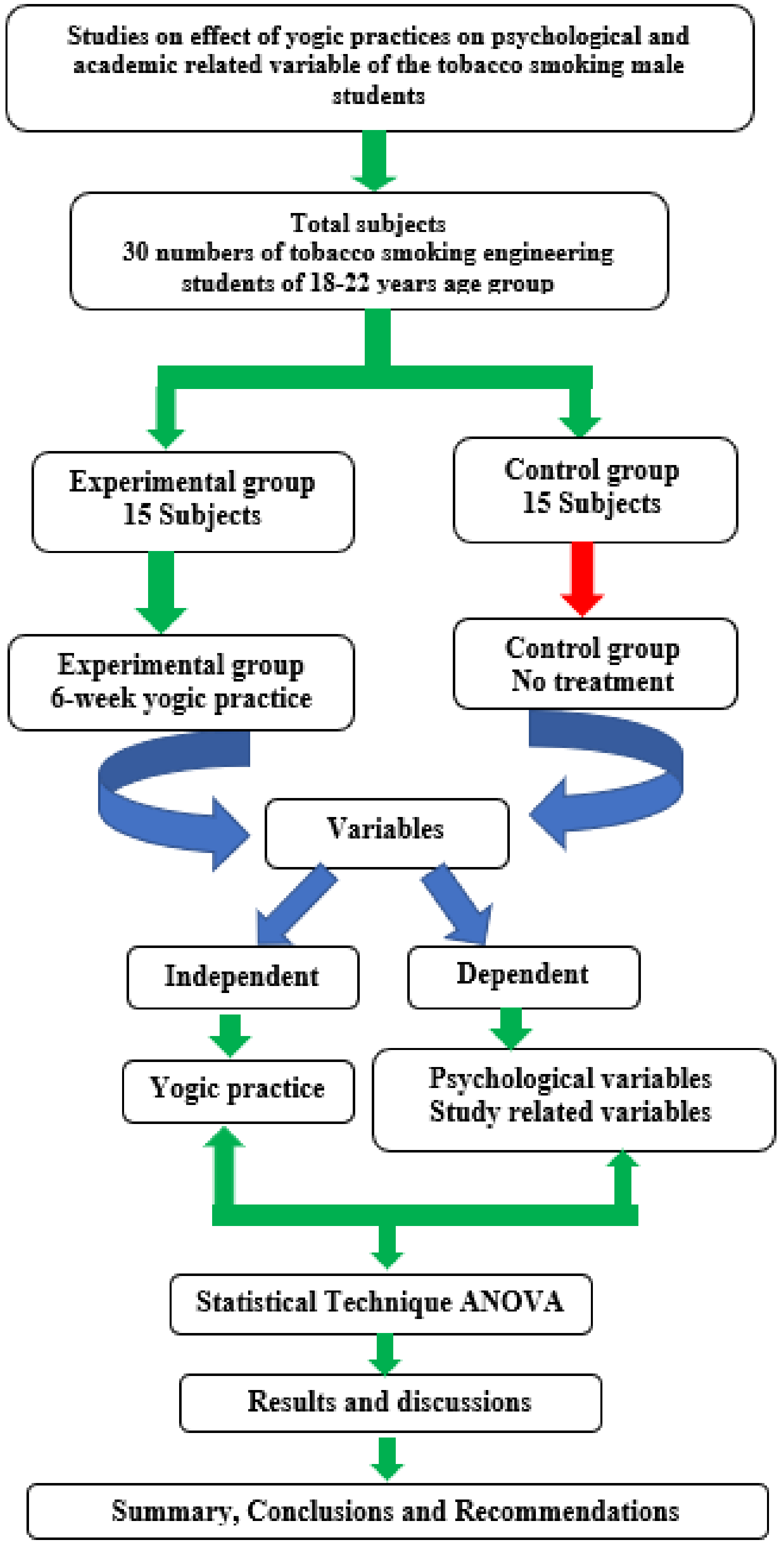

Fig. 1 Work flow of the current study

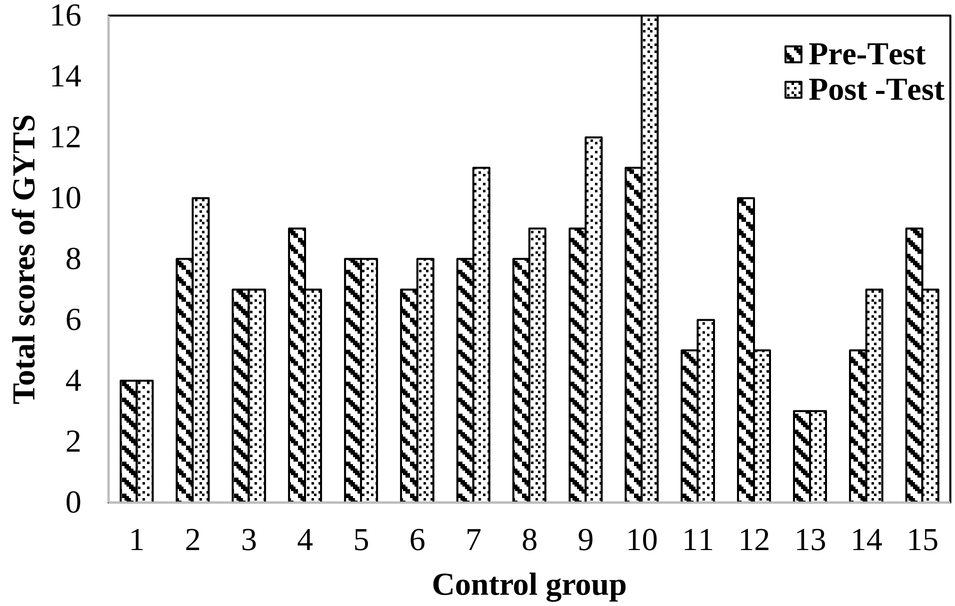

Fig. 2 Comparison of total GYTS scores of the control group

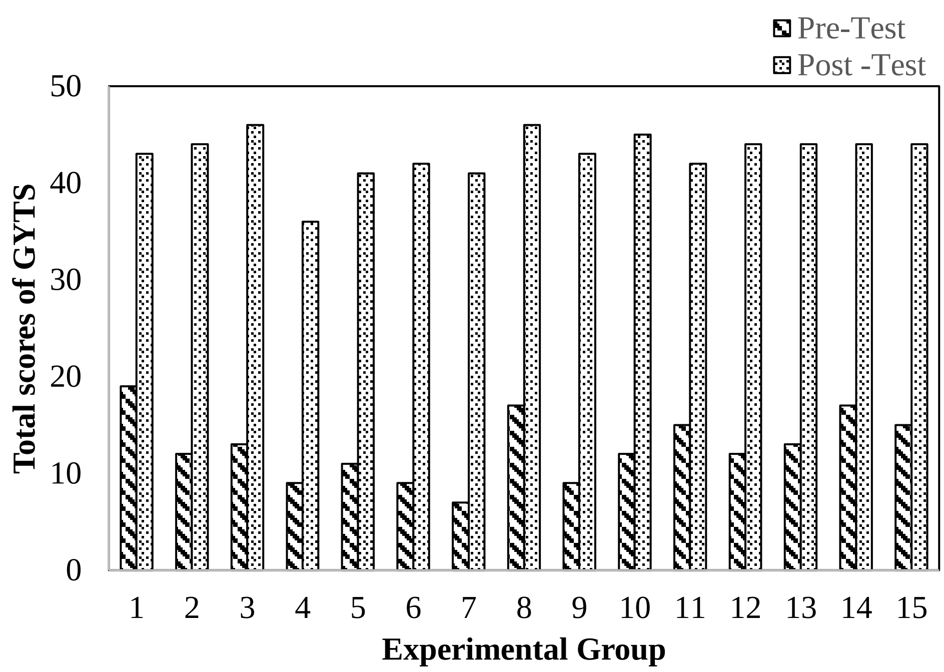

Fig. 3 Comparison of total GYTS scores of the experimental group

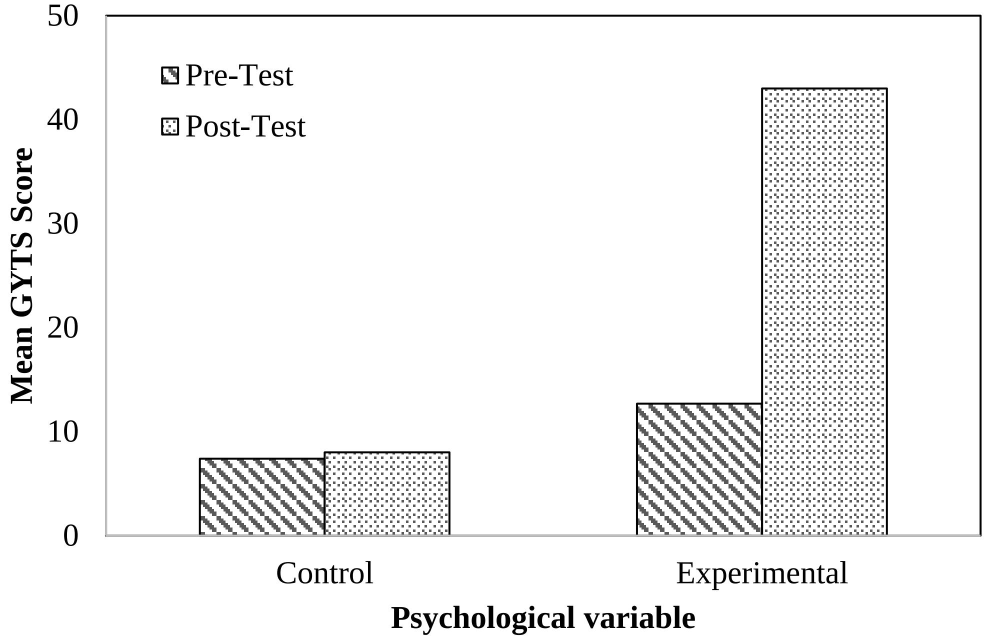

Fig. 4 Comparison of mean scores of the control group and the experimental group

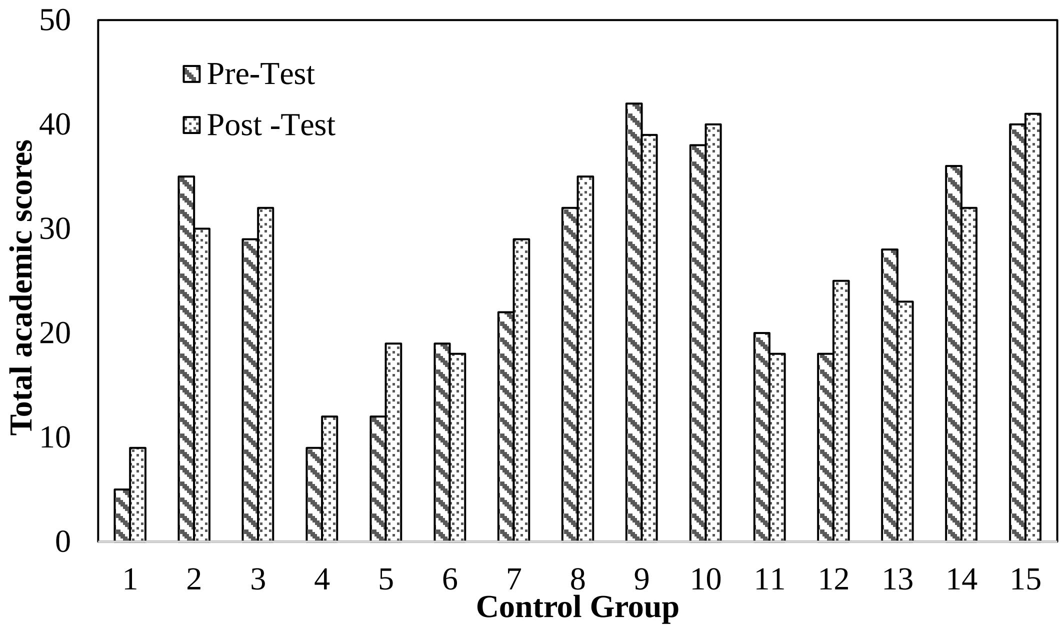

Fig. 5 Comparison of total academic scores of the control group

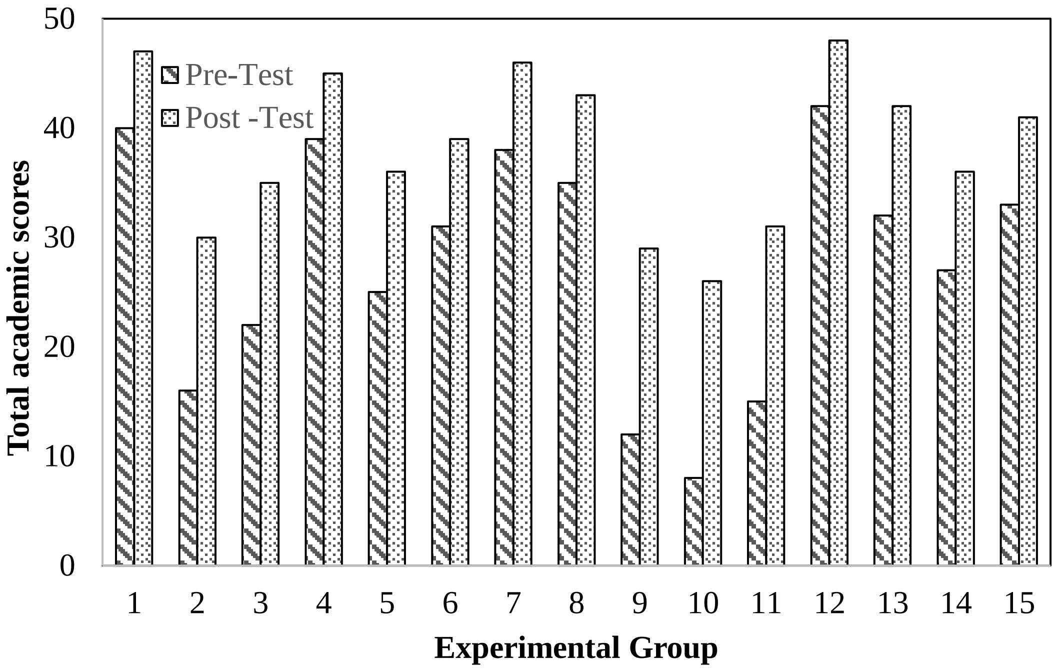

Fig. 6 Comparison of total academic scores of the experimental group

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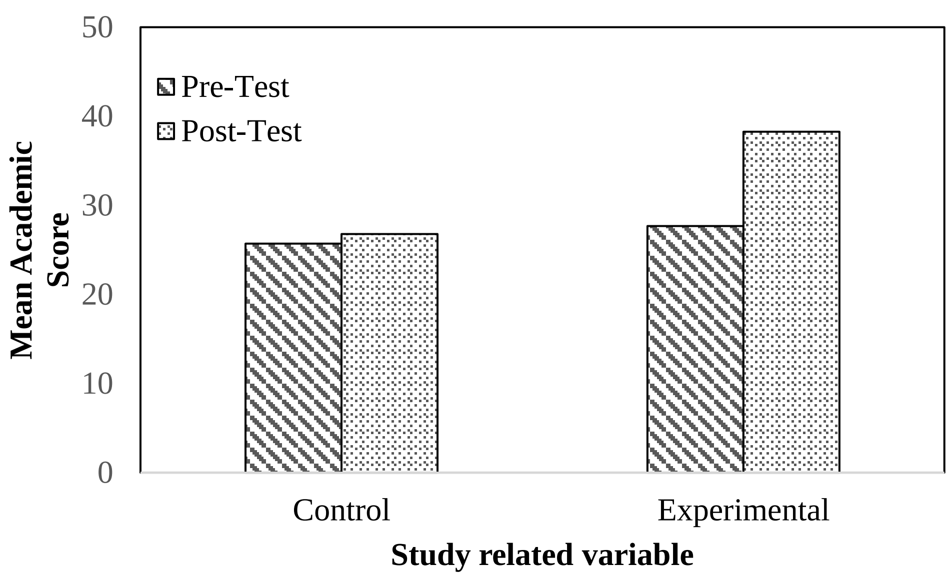

Fig. 7 Comparison of mean academic scores of the control group and experimental group

Table I: ANOVA FOR PSYCHOLOGICAL VARIABLE OF CONTROL GROUP

ANOVA: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Control-pre-test	15	111	7.4	5.1
Control-post-test	15	120	8	10.9

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	2.7	1	2.7	0.338	0.566	4.196
Within Groups	223.6	28	7.986			
Total	226.3	29				

TABLE II: DESCRIPTIVE FOR PSYCHOLOGICAL VARIABLE OF CONTROL GROUP

	Control-pre-test	**Control-post-test**
Mean	7.4	8
Standard Error	0.584	0.851
Median	8	7
Mode	8	7
Standard Deviation	2.261	3.295
Coefficient of variation	0.3055	0.4119
Sample Variance	5.114	10.857
Kurtosis	-0.372	1.295
Skewness	-0.534	0.885
Range	8	13
Minimum	3	3
Maximum	11	16
Sum	111	120
Count	15	15
Confidence Level (95.0%)	1.252	1.825

TABLE III: ANOVA FOR PSYCHOLOGICAL VARIABLE OF EXPERIMENTAL GROUP

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Sample Pre-test	15	190	12.7	11.8
Sample Post-test	15	645	43	6.14

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	6901	1	6901	768.8	6.65E-22	4.196
Within Groups	251	28	9			
Total	7152.2	29				

TABLE IV: DESCRIPTIVE FOR PSYCHOLOGICAL VARIABLE OF EXPERIMENTAL GROUP

	Sample Pre-test	**Sample Post-test**
Mean	12.7	43
Standard Error	0.887	0.640
Median	12	44
Mode	12	44
Standard Deviation	3.436	2.478
Coefficient of variation	0.2706	0.0576
Sample Variance	11.810	6.143
Kurtosis	-0.653	3.855
Skewness	0.217	-1.592
Range	12	10
Minimum	7	36
Maximum	19	46
Sum	190	645
Count	15	15
Confidence Level (95.0%)	1.903	1.373

TABLE V: ANOVA FOR STUDY RELATED VARIABLE OF CONTROL GROUP

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Control-pre-test	15	385	25.7	136.8
Control-post-test	15	402	26.8	102.2

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	9.63	1	9.633	0.081	0.779	4.196
Within Groups	3345.73	28	119.490			
Total	3355.37	29				

TABLE VI: DESCRIPTIVE FOR STUDY RELATED VARIABLE OF CONTROL GROUP

	Control-pre-test	Control- post-test
Mean	25.67	26.8
Standard Error	3.02	2.61
Median	28	29
Mode	--	32
Standard Deviation	11.70	10.11
Coefficient of variation	0.4558	0.3772
Sample Variance	136.81	102.17
Kurtosis	-1.078	-0.995
Skewness	-0.288	-0.233
Range	37	32
Minimum	5	9
Maximum	42	41
Sum	385	402
Count	15	15
Confidence Level (95.0%)	6.48	5.60

TABLE VII: ANOVA FOR STUDY RELATED VARIABLE OF EXPERIMENTAL GROUP

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Sample Pre-test	15	415	27.67	119.52
Sample Post-test	15	574	38.27	49.92

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	842.7	1	842.7	9.946	0.0038	4.196
Within Groups	2372	28	84.7			
Total	3214.967	29				

TABLE VIII: DESCRIPTIVE FOR STUDY RELATED VARIABLE OF EXPERIMENTAL GROUP

Sample Pre-test		Sample Post-test
Mean	27.7	38.3
Standard Error	2.8	1.8
Median	31	39
Mode	--	36
Standard Deviation	10.93	7.07
Coefficient of variation	0.3946	0.1846
Sample Variance	119.52	49.92
Kurtosis	-1.06	-1.18
Skewness	-0.456	-0.260
Range	34	22
Minimum	8	26
Maximum	42	48
Sum	415	574
Count	15	15
Confidence Level (95.0%)	6.054	3.913

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EFFECT OF YOGIC PRACTICES INTEGRATED WITH TRATAKA ON MEMORY AMONG WOMEN WITH SLEEP DISORDERS

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23. Yogic Approach to cope up with Perimenopausal Symptoms during Covid-19 Pandemic

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Abstract

In this article, an attempt is made to suggest the Yogic Practices to cope up with Perimenopausal symptoms during Covid19 Pandemic. Our world is experiencing global Covid-19 Pandemic, caused by severe acute respiratory syndrome coronavirus 2 (SARS‑CoV‑2). Many people particularly elders face difficulty in taking care of their Health as they are at high risk of developing symptoms during this Pandemic. Generally, women are looking after their all household work and family members in between their work schedule but putting themselves at last. Women with perimenopause, menopause and post menopause need special attention as this is the period where potentially serious illnesses may occur. Although menopause is only the moment that menses stops, the transition usually takes many years. This stage is called perimenopause. During the perimenopausal period, fluctuations in estrogen and progesterone levels can cause a variety of symptoms. Hence this article suggests some Yogic practices that Perimenopausal women should follow and they should actively involve themselves to encounter the challenges of perimenopausal symptoms during this Covid-19 Pandemic.

Key words: Yoga, Peri-menopausal symptoms, Covid19 pandemic, Women

Introduction

"It is health that is real wealth and not pieces of gold and silver".

- Mahatma Gandhi

The novel coronavirus was originated in Wuhan city of China, slowly crossed the borders, infecting people all over the world, and now it has been declared a global pandemic by the World Health Organisation (WHO). Immunity weakened people, older people, and people with underlying clinical issues like diabetes, Cancer, some chronic diseases and cardiovascular disease are more prone to develop serious ill health (Adhikari, et al., 2020). To date (August 23, 2020), over 23,057,288 demonstrated cases and 800,907 confirmed deaths have been stated for COVID – 19 across 216 countries. Many countries are taking swift measures to avoid the spread of this virus and People are entering self-quarantine and working at home. But women, as the main caregivers, eventually doing a lot of housework and taking care of family members in between their work schedule on full time basis. Therefore, they will not take care of themselves while taking care of others. Generally, women spend a lot of time in peri menopause, menopause and postmenopausal state in their lives. Most women over the age of 45 in India do not understand the changes in their bodies and spend precious lives fighting with menopausal-related problems and diseases. During this pandemic, perimenopausal women experience hot flashes, night sweats, trouble sleeping, fatigue, joint pain and mood swings (Warren, 2007). Usually, these signs and symptoms confuse women, which will affect their physical and mental health. Recent study proved that 10 to 20 percent of perimenopausal people will experience depression and anxiety for the first time. Menopausal symptoms have been widely studied in women in Western society, but for women of non-Western races, there is less information. Therefore, it is important to understand and control perimenopausal symptoms to improve the physical and mental health of the women.

Perimenopause refers to the transitional period of menopause or "around menopause". Women may start menopause at different ages. Some women may notice signs of the development of vasomotor symptoms with irregular menstruation in their late thirties or early forties. It may last only a few months or up to 10 years depending on their health. The end of perimenopause is when a woman has gone through 12 months of menopause (Baber, Panay & Fenton, 2016). A recent cross-sectional study of women between 40 and 60 years in Shanghai showed that the top five symptoms reported were hot flashes/sweating, fatigue, sleep disturbance, mood swings, and joint/muscle pain (Cheng, et al., 2019). According to Turnbull, about 20% of women experience severe menopausal symptoms, 60% of women have mild symptoms, and 20% of women may have no symptoms at all (Turnbull, 2010). Considering the global outbreak of COVID-19 and reducing the risk of spreading the virus, this is not considered as the good time to go to the hospital. But menopausal women should keep in mind that these symptoms may pose long-term health risks. On the other hand, it must be emphasized that women who have symptoms during perimenopause/menopause may delay seeking health care services, which may lead to the deterioration of existing illness. Therefore, it is important to find various ways to manage symptoms to minimize the discomfort and inconvenience during the menopausal transition period to improve women's physical and mental health.

The necessity to manage perimenopausal symptoms during covid19 outbreak

In women, ovarian hormones estrogen is responsible for immunity, inflammation, and the expression of angiotensin-converting enzyme 2 (Bukowska, et al., 2017). Recent evidence suggests that these effects are lost after menopause, which occurs in Italian women at Median age of 50 years (Cagnacci & Xholli, 2020). ACE2 enzyme is mainly expressed in the endothelial cells of the lung and heart, and it exerts vasodilation, anti-inflammatory and anticoagulant effects in the blood vessels and heart, thereby reducing the progression of COVID-19 disease (Cheng, et al., 2020). ACE2 is encoded in X chromosome, and estrogen stimulates the expression of ACE2 in endothelial cells (Cheng, et al., 2020).

Since estrogen deficiency is the cause of perimenopausal symptoms, estrogen replacement therapy (HRT) is considered as the most effective treatment (Santen, et al, 2010). However, HRT is associated with an increased risk of uterine cancer, breast cancer, thromboembolic heart disease, and stroke. The latest results of the Women’s Health Initiative (WHI) and the Heart and Estrogen/Progesterone Replacement Study (HERS) indicate that women randomized to receive hormone therapy have an increased risk of cardiovascular disease (CVD) and breast cancer (Vaze & Joshi, 2010). Now a days women are aware of these serious side effects and seek for alternative medicines to cope up with their menopausal symptoms (Lunny & Fraser, 2010) and (Bair, et al., 2010). Since recent years, yoga has spread all over the world, and research has been conducted to help people cope with various health conditions such as menopause.

Yoga

Yoga is a Sanskrit word which means Union of body, mind and breath that has been evolved 5000 years ago. It is an ancient Indian traditional system of practices that helps to cure, rejuvenate and prevent most of the diseases on regular practices. Maharishi Patanjali, the father of yoga, described ashtanga yoga which includes yama (self-disciplines), niyama (observations), asana (postures), pranayama (breathing), pratyahara (withdrawal of sences), dharana (focused concentration), Dhyana (meditative absorption) and samadhi (Union). In order to deal with physical illnesses, asana (Postures), pranayama (Regulation of breath), and Dhyana (meditation) are commonly performed (Saraswati & Saraswati, 2002). Some Yogic practices for perimenopausal women includes Supta badda konasana, Salamba Bhujangasana, uttana padasana, Upavista konasana, Parvatasan, Shasangasan, pawanamuktasan,Shavasan, Sheetali, Sheetkari, Nadishadana pranayama and meditation.

These yoga practices can improve hot flashes and night sweats. It can also improve cognitive functions such as mental balance, remote memory, and attention (Chattha, et al., 2008). Compared with physical exercise, even a full eight weeks of yoga therapy has achieved better results in reducing menopausal symptoms, feelings of stress and neuroticism in menopausal women (Chattha, et al., 2008). Studies have proven the effectiveness of yoga in improving sleep patterns, showing that it can be effectively used to combat insomnia and other sleep disorders in postmenopausal women in a clinical setting (Khalsa, 2004). These yogic practices improve endocrine function and increases parasympathetic activity, estrogen and progesterone in perimenopausal women which indicate that yoga can be a protective alternative therapy for perimenopausal women during this pandemic (Khadka, et al., 2013).

Conclusion

"Prevention is better than cure".

- Desiderius Erasmus

Many studies proved that yogic practices have great impact on menopausal syndrome. Therefore, it is strongly recommended to women in all menopausal stages. Regular yoga practice can make women's menopausal experience unique. One's life and destiny are in their own hands - one's actions and decisions decide one's fate, considering this, perimenopausal women should start practising yoga to ease the transition process during Pandemic.

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Kala Sarovar Quarterly Journel Approved by UGC Care List

कला सरोवर

KALA SAROVAR

(भारतीय कला एवं संस्कृती की विशिष्ट शोध पत्रिका)

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Abstract

The prime objective of the study was to find out the effect of yoga on heart rate and hand-eye coordination among archers. Two groups were separated; experimental group and control group; 10 Archery players were considered as experimental group and others were considered as a control group. The yogic practices were administered only to the experimental group. The Resting heart rate and the hand-eye coordination of the players were measured before and after the 8 weeks. The collected data were examined using the Analysis

of Covariance statistical technique. The results showed that the eight weeks yogic practice significantly regulates the Heart rate and improves hand-eye coordination among Archers.

Keywords: Yoga, Archers, Heart rate, Physiological, Sports, hand-eye coordination

INTRODUCTION

Archery is a sport requiring a variety of qualifications from a constant hand, strong shoulders, flexible muscles, a sharp eye, and a cool feeling. Two areas of archery are classified: target and field. Target archery requires archers to shoot certain arrows at certain targets with values, for instance, 10 points for a bullseye. Field archery comprises an open field target range where archers shoot various arrows at various targets or distances along a runway. This resembles the kind of shooting while hunting. Target archery was an important element during the 1900-1920 Olympic Games, but only in Munich in 1972 and has been a staple ever since. Several archer studies have shown that during competitions there is a noticeable impact on the cardiovascular system of archers **(Carrillo et al., 2011)**. Although the cardiological values are changed before drawings, drawings the bow and after, and shooting impacted by psychophysiological variables, there is also some muscle stress imposed on whole body muscles, chest and shoulder girdle muscles due to posture, restricted shot duration, and repeated shooting **(Robazza et al., 1999)**. A complete body tremor induced by the cardiac systolic cycle is a difficulty for sports that involve shooting, in which hand-eye coordination is crucial for shooting capabilities and performance **(Helin et al., 1987)**. The duration of systolic and diastolic phases of the HR-based cardiac cycle alters and higher HR reduces diastolic and systolic phases **(Guyton and Hall, 2006)**. Similar to the archery, greater HR levels are considered to have a low correlation of scoring points, which implies a detrimental influence of tremors caused by HR on the precision of the targeting **(Konttinen and Lyytinen, 1992)**. However, the archers display more Heartrate during the tournament. **Carlson (1984)** says that some visual abilities have a greater part in archery. According to **Gardner and Sherman (1995)**, visual accuracy, coordination of the eye-hands, visual adjustment, and central-peripheral awareness are essential for archers. **Paillard (1990)** says that hand-eye coordination is "a perceptual and

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motor skill that integrates and processes visual and tactile input into central neural systems so that intentional motor movement may be achieved". Consistent with **Ferreira (2001),** "The hand-eye coordination influences the efficacy of a perceptive-motor response to a visual input". **Strydom (2010)** suggested the importance of eye-hand coordination in the sport of archery cannot be overstated, since most archers performed well when this visual ability was tested. To improve the performance among archers, yoga is one of the best practices worldwide to bring balance between the sympathetic and parasympathetic nervous system. Yogic practices include yoga asana, pranayama, and meditation. It helps to improve flexibility, cardiovascular endurance, breathing capacity, and also mental health that aid in the betterment of archery performance. As Resting heart rate is directly associated with health-related physical fitness components includes cardiorespiratory fitness, handgrip strength, flexibility, and body composition, Hand-eye coordination improves the current performance of the archers, this study focuses on the effect of yogic practices on Heart rate and Hand-eye coordination among archers.

PURPOSE OF THE STUDY

The purpose of this study was to find out the effectiveness of yoga on Heart rate and hand-eye co-ordination among archers.

HYPOTHESIS

It was hypothesized that eight weeks of yogic practices would have a significant effect on Heart rate and Hand-eye coordination among archers.

METHODOLOGY

The purpose of the study was to find out the effectiveness of yoga on Heart rate and Hand-eye coordination among archers. 20 athletes from the Archery club participated. All subjects were requested to sign a consent form and explained the technique of the study and the testing. In this study, two groups were targeted; experimental and control group; 10 archery players were considered as the experimental group, and 10 other archery players were considered as the control group. The experimental group gone through 8 weeks of yogic practices 5 days a week. The yogic practices included Suryanamaskar, specific asana, pranayama, and meditation for one hour. The Control group didn't undergo any such practices. After eight weeks, all participants adhered the next competition. Same to pre-test, post-test was executed one hour before the game to find out the level of heart rate using Heart rate monitor before and after the 8 weeks. The hand-eye coordination of the subjects was measured by a mirror drawing test. The score was recorded as the number of total errors and the score was taken to complete one trial and recorded in seconds. The collected data was analysed through the Analysis of Covariance statistical technique. The level of significance was fixed at 0.05.

RESULTS AND DISCUSSIONS

Table -I showing the results of Analysis of Covariance on Heart rate.

Test	EXP. Gr	CG	SV	SS	Df	MS	F
Pre test	75.90	76.30	Between	0.80	1	0.800	0.09
			Within	165.00	18	9.17	
Post test	69.10	76.80	Between	296.45	1	296.45	25.11*
			Within	212.50	18	11.81	
Adjusted	69.29	76.61	Between	267.34	1	267.34	63.85*
			Within	71.183	17	4.19	

Table F ratio of 4.41 with (1, 18) degrees of freedom *Significant at 0.05 level

In addition to the needed F value 4.41 at 0,05 level, the F value achieved for the adjusting post-test indicates 63.85 was larger. Statistical analysis using ANCOVA showed a significant difference between the control group and the experimental group on heart rate. The results of this study show that eight weeks of yoga reduces heart rate. The outcomes of this study are based upon the effects of yoga practises found by of Sawane & Gupta, (2015) and Mandal (2019).

Figure-1 Showing the pre-test, post-test and adjusted post-test mean values of Heart rate

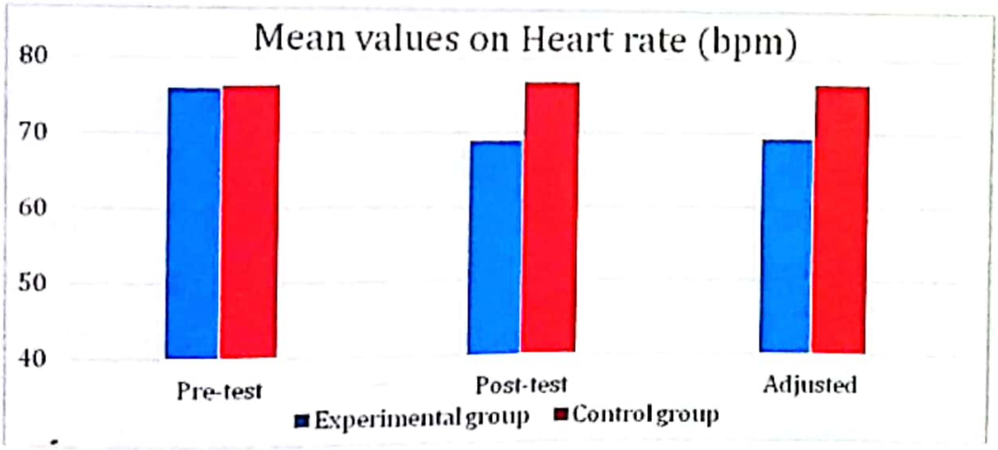


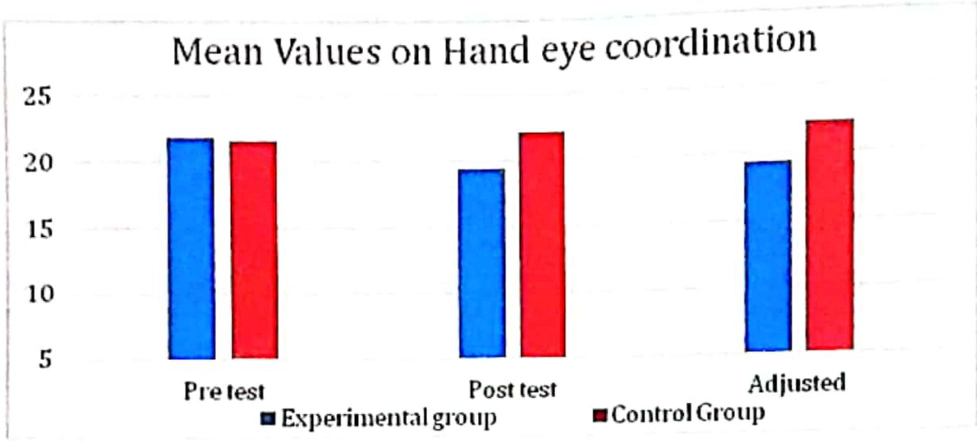
Table – II showing the results of Analysis of Covariance on Hand-eye coordination

Test	EXP. Gr	CG	SV	SS	Df	MS	F
Pre test	21.90	21.60	Between	0.45	1	0.450	0.23
			Within	35.30	18	1.96	
Post test	19.40	22.20	Between	39.20	1	39.20	14.70
			Within	48.00	18	2.67	
Adjusted	19.28	22.32	Between	45.87	1	45.87	32.70
			Within	23.846	17	1.40	

Table F ratio of 4.41 with (1, 18) degrees of freedom ***Significant at 0.05 level**

In addition to the needed F value 4.41 at 0,05 level, the F value achieved for the adjusting post-test indicates 32.70 was larger. Statistical analysis using ANCOVA showed a significant difference between the control group and the experimental group on hand-eye coordination. The results of this study show that eight weeks of yoga improves hand-eye coordination. The outcomes of this study are based upon the effects of yoga practises found by of Maiti et al. (2016) and Alaspure, (2016).

Figure -2 showing the pre-test, post-test and adjusted post-test mean value of Hand-eye coordination.



CONCLUSION

Yogic practices had an impact on reducing the Heart rate and improving the hand-eye coordination among Archers.

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PAPER • OPEN ACCESS

Spectroscopy Analysis for Quality Control Measurement in Waste Management

SPECTROSCOPY ANALYSIS FOR QUALITY CONTROL MEASUREMENT IN WASTE MANAGEMENT

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Abstract. This work explains about the physic-chemical characteristics of composites to evaluate the applicability in various purposes over agricultural area. Spectral characteristics of compost materials are compute with spectroscopy with Fertility index and clean index. This FI of composites was observed for sampling with various classification of higher fertilizing potential. Composites are utilized as fertilizer owing to low fertilizing potential. The concentration has been determined within permissible limits of fertility standards. It is known that these composites is more appropriate option for waste processing as it diminishes weight of organic waste. This analysis is performed with spectroscopy analysis.

Index words - composites, spectroscopy analysis, waste management, agricultural region, quality control

1. Introduction

Various scenarios of waste management is extremely unsatisfactory. It is known that total was generated in India. The overall waste generated was collecting waste efficiency is 70% and treating remaining proportion of not being collected. Average collection of effectual waste is significantly effectual with lacking of waste management. Moreover, improved migration rate from rural to urban regions are overwhelm growth of various cities. This may causes further increased growth in urban regions. Waste fraction variations based on economic condition. At present, solid waste rate in variation may vary from rural to urban location. This is expected to improve further urban regions. The waste management produced in most cities is problem crisis is slightly higher in management. Moreover, increased generation of waste management are influx with population and growth of cities. Some crucial stage of reached owing to unavailability of appropriate facilitates dispose those quantities of wastes. This inappropriate management of solid waste is crucial concern in developing countries. Specifically, with dumping wastes are easier and cost effectual for disposal. The waste

management lack comprises of treatment and collection may leads to global warming as organic waste fraction is cause of gas emission.
Composition, incineration, burning, recycling and dumping in landfills are certain other components of waste management process. Moreover, waste disposal is a matter for growing world. With faster increase in population rates may influence is generation and characteristics patterns of waste management with improved industrialized and urbanization for developing a proper waste management systems.

Waste management characteristics are a crucial feature in appropriate waste management. Waste management produced from various services comprises of sweeping, animal waste, domestic wastes, market wastes, commercial wastes and industrial wastes. However, solid waste comprises of higher amount of hazardous and toxic characterization and owing to direct exposure of waste leads to environmental pollution.

Waste management has some traits which are specifically various from other regions including climatic variations, lesser population density, dumpsites which makes it complex to appropriate waste management. Moreover, waste management is extremely sensitive owing to influences other factors like increased developmental activities, socio-economic conditions. With raised industrialization and superior level of resources causing improved management generation and complex composition of waste management. Increased rate of waste generation is economic prosperity in regions. In context to this, bio-degradable fraction is produced more significantly on superior side in comparison to plain regions in country. Average physical characterization of waste variations are studied in regions.

The outcomes are revealed that more fraction of waste comprises of bio-degradable waste, second highest fraction of total waste in India. Chemical characterization of waste revealed that appropriate amount of moisture content and organic matter is presented in solid waste. Compositing is biological decomposition process that may transforms organic matter into stabilized nutrients content by microbial activities that are utilized for nourishment and enrichment of soil fertility. Composting process uses controlled condition to biologically decompose solid wastes. Moreover, composting consumes lesser time for degradation than composting an-aerobic materials. The most promising solution is to enhance solid waste management system with minimal amount of solid wastes, maximal amount of waste recycling and resource recovery. The application relies over agriculture which is of low cost to incineration or landfill disposal. This compost is measured as a soil fertilizer as it comprises of maximal nutrients to plants comprising phosphorus, nitrogen, potassium and organic materials that may boost soil properties by improving water and soil aeration with holding capacity.

It is essential to show compost of soil waste that has probability of bio-accumulation of metals and may cause threat to humans and breaks down the food chain. The presence of these kinds of metals may leads to blood related problems and bone disorders, neurological and kidney damage. Various compost generating companies may use diverse techniques and non-uniform feedstock that leads to production of various compost grades. Moreover, compost nature is extremely influenced by type, composting facilities, methodologies and maturation period. Compost nature is generated from mixed waste which is of poor quality and non-marketable financial loss. Certain standards are fixed to grade compost generation and come use of grade pertaining. Some standards may be prescribed by fertilizer control order. Quality control standards may suffers from diverse disadvantages that may include compost quality with fertilizing factors however non-complaint context of metal allowed for potential reuse. This may harm and restricts organic waste utilization. Some standards may fails in identifying complete quality owing to composting type and inputs provided. It may reject superior quality by generating better techniques. Revised approaches are used for classification to maximize compost potential and eliminate contamination of agricultural soils and offer superior resource utility for manufacturers based on computational fertility index and clean index values. This facilitates identification of compost application that ranges from growth of higher crop values, food crops and gardening.

This investigation concentrates on providing spectroscopic analysis from dump-sites of regions that may includes various agricultural regions of India to examine structural changes and nutrients concentration during this compost processing. This is assessed for potential usage for determining fertility and clean index.

2. Proposed Method

Generally, metal analysis was performed on atomic spectroscopy absorption with acetylene and correction lamp utilized as fuel for superior concentration when thermal atomization in furnace as carrier gas was considered as lower concentration.

Compost quality analysis

Compost quality samples at both locations are classified as 'Fertility Index' and 'Clean Index' with revised indices approaches to demonstrate composted usability produced with market value. Determination criteria of weighting factor are given for parameters are discussed in various literatures. To provide a conclusion, weighting factor for various parameters is change based on five point scale based on significance towards soil productivity enhancement. Fertility index values of diverse samples are computed with certain functionalities in Eq. (1):

$$FI = \frac{\sum_{n}^{i=1} S_i w_i}{\sum_{n}^{i=1} w_i} \tag{1}$$

Where S_i is source value and w_i is weighting factor of fertility factors of analytical data. Weighting factor may changes from 1 to 5 dependent on toxicity level of various factors. Clean index of diverse compost are evaluated with subsequent computation provided in literature. Superior value of CI is specified by lesser amount of heavy metal contamination and vice versa as in Eq. (2):

$$CI = \frac{\sum_{n}^{i=1} S_j w_j}{\sum_{n}^{i=1} w_j} \tag{2}$$

Here, S_j is score value, w_j is weighting factor of heavy metal factors of analytical data. The compost quality computation is done with nutrient level and maturity is essential to provide probable use of compost produced. Preliminary factors used for compost quality computation are given in Table. Compost sample temperatures over subsequent decomposition process are measured to be 60^o C for various regions. Similar compost samples are recorded when composting was performed. Temperature change is attributed to exothermic procedure provided by microbial organic matter decomposition. This shows that decomposition process, temperatures are divergently computed with comparison of temperature sensed after degradation completely. Total Organic Carbon shows amount of organic factors available in solid waste composite materials. It is noted that TOC for these regions are specified. Moisture content of agricultural field is measured as an essential factor in helping storage and transporting ease of complete compost materials. Range of moisture content for both regions may vary based on ranges revealed. However, these values are drastically higher than standard prescription by fertility control order. Compost sample pH values are provides based on various ranging factors from 7 to 8. Therefore, pH values of these samples within alkaline-neutral range thereby shows organic decomposition matter. With various studies municipal pH waste composed may changes. pH alkaline causes ammonium gas formation in air that pretends to raise harmful pathogenic bacteria in atmosphere.

Electrical conductivity is also an essential factor to provide nutrition level and chemical properties of compost. Electrical conductivity values are observed as 6dS/m in composting periods. Values of these studies may slightly rises with permissible limit in India. Clean index and fertility index of compost are quality factors for demonstrating compost gradients with market value. There are seven classes of compost quality classification based on determination. This provides finest quality compost and market value which is utilized for high value crop and organic farming. Remaining classes are useful and not plied for organic farming. Weighting factors and score value to compost for fertility index and clean index computation. FI determines compost sampling and observed for various days. Therefore, compost is classified as maturation period. As well CI value is also computed for sampling periods. This compost may fulfil certain criteria with standards as metal concentrations are lesser than FCO standards.

3. Results and discussions

This section discusses in detail about the compost computation and the characteristics of compost that are related to spectroscopy and physico-chemical analysis. Table 1 and Table 2 depicts compost standardization and FI/CI values respectively. Fig 1- Fig 6 depicts solid waste analysis with spectroscopy for 20th, 40th and 60th day respectively.

Table I: Compost standardization

S.No	**Parameters**	**Standardization**
1	C/N ratio	20
2	Potassium	1
3	Phosphorus	0.5
4	Nitrogen	0.5
5	Organic carbon	6
6	Magnesium	-
7	Calcium	-
8	Moisture	20-25
9	Conductivity	<4
10	pH	6.5-7.5
11	Temperature	-

Table 2: FI and CI values

S.No	Class	FI	CI
1	A	>3.6	>4.1
2	B	3.2-3.6	>4.1
3	C	>3.6	3.2-4.1
4	D	3.2-3.6	3.2-4.2
5	RU-1	<3.2	-
6	RU-2	>3.6	>4.2
7	RU-3	>3.6	-

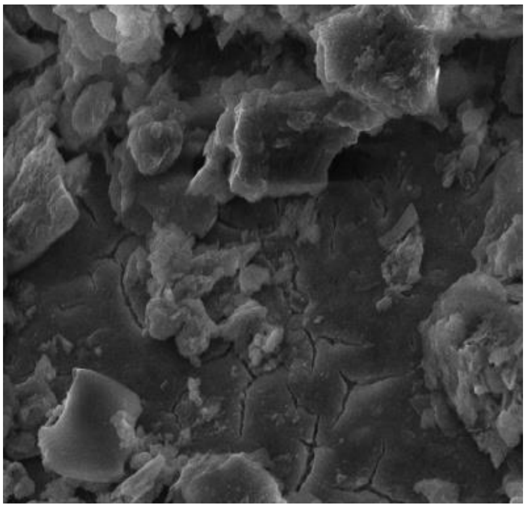

Fig 1: Solid waste in 20th day

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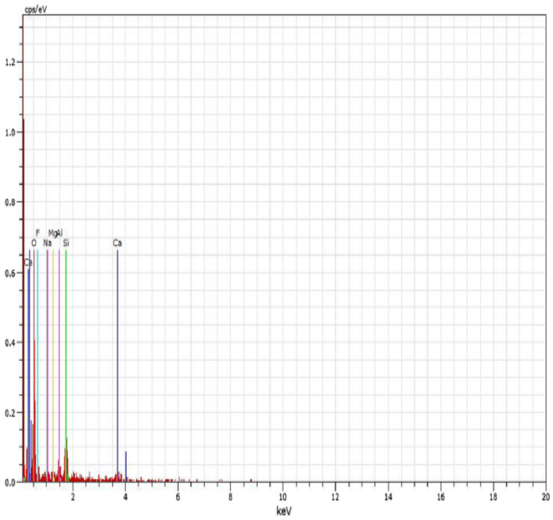

Fig 2: Spectroscopy analysis of SW in 20th day

Fig 3: Solid waste in 40th day

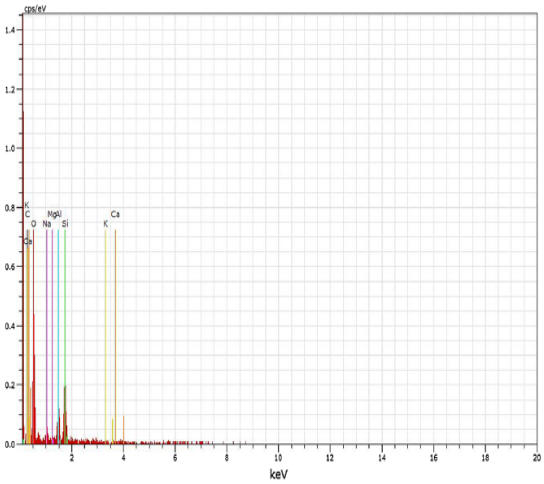

Fig 4: Spectroscopy analysis of SW in 40th day

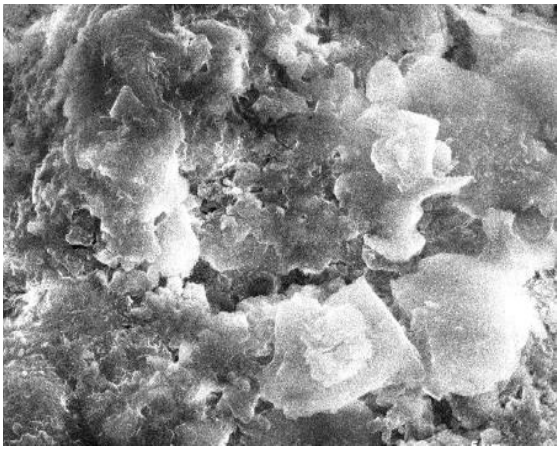

Fig 5: Solid waste in 60th day

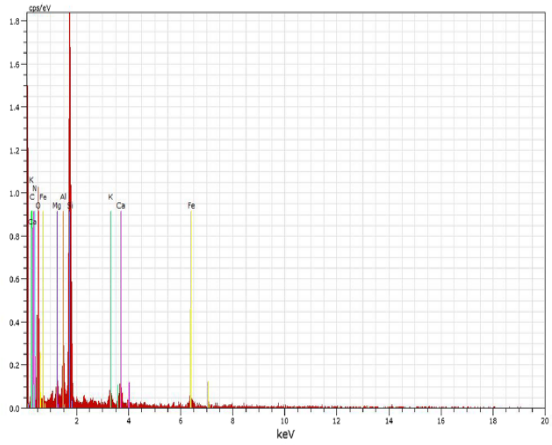

Fig 6: Spectroscopy analysis of SW in 60th day

The solid wastes are generated with higher biodegradables proportion that is easily produced as compost ad utilized as natural fertilizer. Moreover, prevailing scenario of extremely not fulfilling. At varying time, two compost pits are studied under working condition and stops composting process owing to its non-economic viability. This trend is a state of prevailing composting system that may gradually loses its functionality. Closure cause may shows geographical issues, communication breakdown and functionality under partnership, non feasibility produced and lack of funds for smoothing plant operation. The foremost cause was availability lack in compost plant operation.

As noted from this study, compost produced in these locations is of higher quality. However, plant that is installed in dump regions may process bio-degradable waste may works in certain working scenario.

4. Conclusion

Physical characteristics of solid wastes are rich in organic content. Therefore, composting is an appropriate option for organic fraction of waste management as it is extremely cost effectual and it is utilized as plant fertilizers and assist in waste burden reduction. It is noted that various investigations based on physic-chemical properties may give compost moisture content, electrical conductivity and complete organic carbon with permissible limits. Heavy metal at initial degradation of organic materials was higher however with rise in time and completion process decrease in heavy metal concentrations. Clean index and fertility index analysis shows that compost has limited usage on fertility control. To consider this compost value and usability based on agricultural view point. It is essential for appropriate segregation waste and compost treatment to application and used for higher values of food crops.

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Investigation on aisi 430 ferritic stainless steel weldment by Tig, Mig welding and continuous drive friction welding

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Investigation on aisi 430 ferritic stainless steel weldment by Tig, Mig welding and continuous drive friction welding

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Abstract. This work describes the study conducted on the macrostructure, microstructure and Tensile strength characteristic of AISI 430 Ferritic stainless steel joints by TIG Welding, MIG Welding and Friction Welding. A detailed analysis was conducted on mechanical property by ANOVA for each of the weldment. The output of the investigations exhibits that the weldment made by MIG has the high tensile strength (580 MPa) than the weldment made by FW (536 MPa) and TIG (492 MPa). The influence of process parameters on mechanical characteristics of weldment by MIG, TIG and FW were individually discussed. The fracture surface analyzed using SEM and found that FW weldment free from defects like carbide precipitation, stress corrosion cracking, sigma phase formation, high heat affected zone, joint distortion were usually occurs in stainless steel weldment by TIG and MIG. The microstructure of the weldment by MIG and TIG is found to be heterogeneous and the same is found by schaeffler diagram.

1. Introduction

Ferritic stainless steel contains chromium in the range of 11-30% and some other elements like nickel and manganese. They have high ductility and formability. It has a broad range of applications in the fields of steam turbine shaft, pump shaft, furnace parts, heat exchangers tubes, solar water heaters and beverage sectors. Friction welding, MIG welding and TIG welding methods are most economical and highly productive methods in joining of Ferritic stainless steel.

Good tensile strength and bend ductility, obtained by friction welding of stainless steel and aluminium with more upsetting pressure and opportune friction time [1]. Good weld could be obtained for joining of AISI 304 Austenitic stainless steel and AISI 4140 low alloy steel by TIG welding, EBW and FW [2]. Pulsed current TIG welding is gives good fatigue performance than continuous current gas metal arc welding for joining of aluminium alloy (AA7075)[3]. Friction welding is used to join AISI 430 ferritic stainless steel which gives 90 to 95% of base material's tensile strength [4].The copper and alumina joined by continuous drive friction welding process which tensile specimens failed at the aluminium interface due to the micro cracks [5].The bonding of alumina and mild steel were achieved by friction welding process through narrow intermetallic phase formation and interfacial interlocking [6]. A low thickness stainless steel plate welding achieved without burning by Key hole-TIG welding [7]. The content of CrN decreases and austenite increases in the case of 12 mm thick plate of duplex stainless steel deep penetration TIG welding [8]. A balanced austenite-ferrite microstructure in the weld metal exhibited in the hyperbaric flux cored arc welding of duplex stainless steel [9]. The joining of copper with stainless steel achieved by DSAW TIG-MIG welding without preheating and grooving and tensile test reveals that optimal tensile strength of 229 MPa and fracture occurs at the copper side [10].The CrN precipitation is gradually vanished and the austenite contend increased in when the heat energy input in the range of 2-2.5kJ/mm for the welding of S32101 DSS by KTIG [11].The toughness of the weld metal increased with an increase in austenite content of S32101 DSS plates welded by KTIG welding system [12].Dissimilar weld between P92 steel and 304H austenitic stainless steel by A-TIG Welding obtained without any defects like undercut, porosity and lack of penetration [13].Current applied is mostly influencing than gas flow rate for MIG welding of AISI 316L Austenitic stainless steel to obtain good strength of the joint [14].High tensile strength obtained in arc-bracing joint compared with fusion welding for titanium alloy with stainless steel material combination [15].This work presents the study on AISI 430 ferritic stainless steel welded by TIG, MIG and FW. Every weldment, studies were conducted on mechanical properties and microstructure behaviour.

2. Materials and methods

In this work experiments were conducted by gas tungsten arc welding, gas metal arc welding and continuous drive friction welding. The material employed in this is AISI430 Ferritic stainless steel and their composition available in Table1.The process variables used for GTAW, GMAW and experimental plan shown are table 2 and table 3 respectively. The process parameters used for friction welding and experimental plan are shown in Table 2 and Table 3 respectively. Samples welded by GTAW, GMAW were 150 x 50 x 10 mm size shown in Figure 1 and FW was cylindrical shape of diameter 12mm and length 100mm.Tensile test specimens were prepared by ASTM E8M and friction welded tensile test specimen shown in figure 2.

Table 1. Base metal chemical composition

Element	C	Cr	Ni	Mn	Si	S	P	Mo	Fe
%	0.12	16.39	0.45	1.59	0.42	Nil	0.028	0.22	balance

Figure 1. MIG Welded Samples.

Figure 2. Friction Welded Tensile Test Specimen.

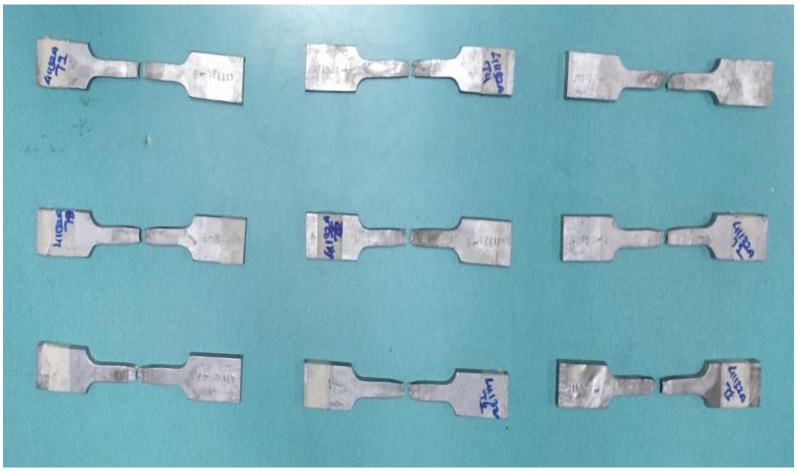

Figure 3. Photograph of Tensile Fractured Weldment made by TIG.

Table 2. Process Parameters for MIG and TIG.

S.No	Parameters	Ranges
1	Current (A)	100 to 140 Amp
2	Voltage (V)	12 to 16V
3	Speed (mm/min)	110 to 130 mm/min
4	Electrode gap (mm)	1 to 3 mm

Table 3. Experimental Plan-L9 Orthogonal Array.

S.No	Arc Current (A)	Arc Voltage (V)	Travel Speed (mm/min)	Electrode gap (mm)
1	100	16	110	3
2	100	14	120	2
3	100	12	130	1
4	120	16	110	1
5	120	14	120	3
6	120	12	130	2
7	140	16	110	2
8	140	14	120	1
9	140	12	130	3

Table 4. Process Parameters for friction welding.

S.No	Parameters	Ranges
1	Friction Pressure	20 to 30 (MPa)
2	Friction Time	3 to 7(sec)
3	Forging Pressure	40 to 50(MPa)
4	Rotational Speed	600 to 1000 (rpm)

Table 5. Experimental Plan-L9 Orthogonal Array.

S.No	Friction pressure(MPa)	Friction time (sec)	Forging pressure (MPa)	Rotational speed (rpm)
1	20	7	40	1000
2	25	5	45	800
3	30	3	50	600
4	20	7	40	600
5	25	5	45	1000
6	30	3	50	800
7	20	7	40	800
8	25	5	45	600
9	30	3	50	1000

Table 6. Mechanical properties of weldment by MIG, TIG & FW.

welding Sample	Ultimate Tensile Strength (MPa)		
	MIG	TIG	FW
1	564	453	518
2	558	459	508
3	557	465	518
4	570	320	507
5	553	490	515
6	565	492	530
7	567	486	523
8	580	491	534
9	552	480	536

3. Results and discussion

To predict the quality of weld, the ultimate tensile strength of welded joint obtained by three different welding techniques such as MIG, TIG and FW as per ASTM E8M standard. All the specimens' failure takes place in the joint interface in a ductile mode, it shows that joints have low tensile strength due to base metal composition affected by welding processes. Base metal UTS is measured as 560MPa but MIG welding gives maximum of 580MPa which is 3.57% greater than base metal while minimum of 552MPa which is 1.42% lesser than base metal. TIG welding produces maximum of 492MPa which is 12.14% less than base metal while minimum of 320MPa which is 42.85% lesser than base metal. In friction welding joint attains maximum of 536MPa which is 4.28% less than base metal while minimum of 507MPa which is 9.46%lower than that of base metal. Welding of metal AISI430 by MIG, TIG and FW techniques produced satisfactory joints in terms of mechanical properties at atmospheric temperature. The UTS of joint made by MIG is higher than TIG and FW. In this work the Signal/Noise ratio has been selected as per criterion greater is best to maximize all the output result. The main effect plot for ultimate tensile strength has shown in figures 4, 5 and 6 for MIG, TIG and FW respectively. This plot developed using MINITAB software. The rank (1) in Table 7 shows that electrode gap is a most significant effect rank (2) speed, which is a more significant effect, while rank (3) voltage is significant effect and rank (4) current has minimum effect on MIG welding process.

Table 7. S/N Ratio of UTS for MIG Welding.

Level	Arc Current (A)	Arc Voltage (V)	Travel Speed (mm/min)	Electrode gap(mm)
1	54.96	55.07	55.11	54.91
2	55.00	55.02	54.96	55.02
3	55.06	54.93	54.95	55.10
Delta	0.10	0.14	0.16	0.19
Rank	4	3	2	1

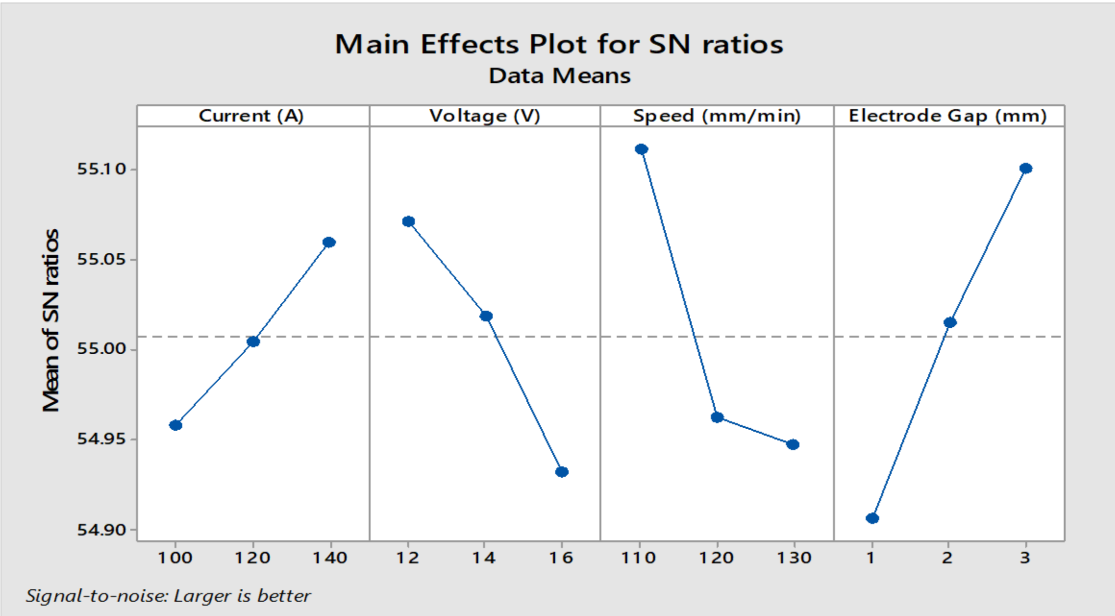

Figure 4. S/N Ratio plot for Tensile strength of MIG welded AISI 430 Metals.

Table 8. S/N Ratio of UTS for TIG Welding.

Level	Arc Current (A)	Arc Voltage (V)	Travel Speed (mm/min)	Electrode gap(mm)
1	53.24	52.32	53.59	53.52
2	52.58	53.62	52.32	53.60
3	53.73	53.60	53.63	52.42
Delta	1.14	1.30	1.31	1.18
Rank	4	2	1	3

Table 8 shows that Travel Speed of welding has a most significant effect, Arc voltage has more significant effect, electrode gap has significant effect and current has minimum effect on TIG welding process.

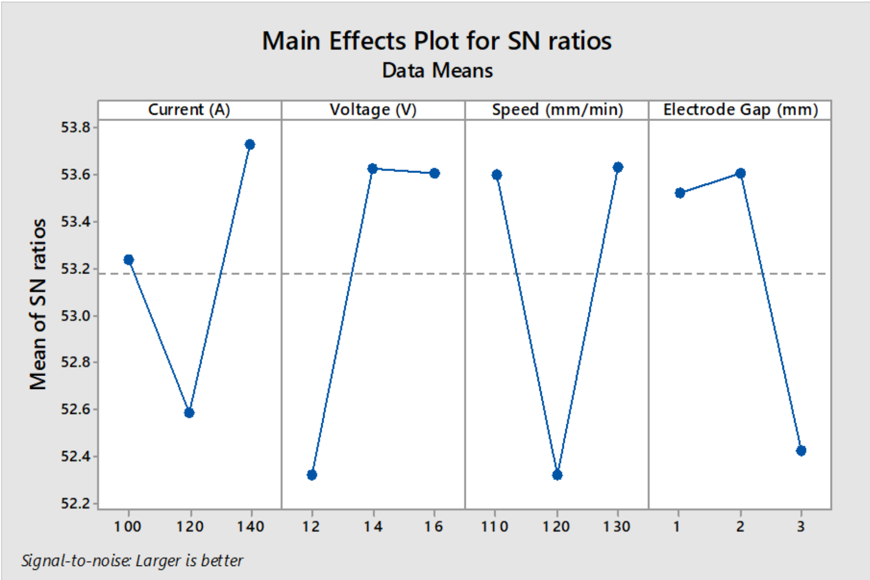

Figure 5. S/N Ratio plot for Tensile strength of TIG welded AISI 430 Metals.

Table 9. S/N Ratio of UTS for Friction Welding.

Level	Friction pressure(MPa)	Friction time(s)	Forging pressure(MPa)	Rotational speed(rpm)
1	54.23	54.25	54.44	54.37
2	54.27	54.30	54.27	54.32
3	54.50	54.45	54.30	54.31
Delta	0.27	0.20	0.17	0.06
Rank	1	2	3	4

Table 9 shows that friction pressure has a most significant effect, friction time, which has a more significant effect, forging pressure has significant effect and rotational speed has minimum effect on Friction welding process.

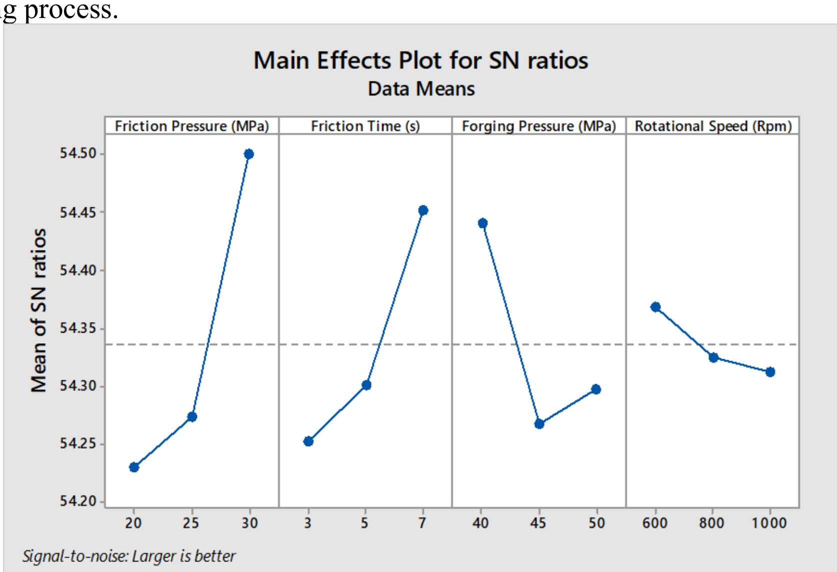

Figure 6. S/N Ratio plot for Tensile strength of Friction welded AISI 430 Metals.

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4. Macrostructure

Joints produced by MIG, TIG and FW were fully penetrated. Macrostructure of the joints shown in figures 7-9.The width and depth of penetration are unlike for weldment made by above 3 joining technique. This is due to changes in parameters and energy input used in the different joining techniques.

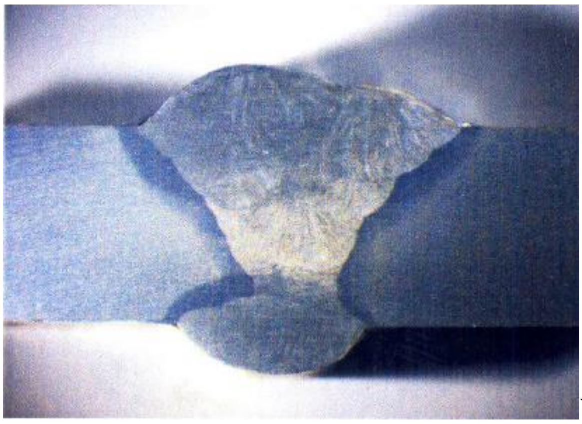

Figure 7. Macrostructure of MIG welded AISI 430 Metals.

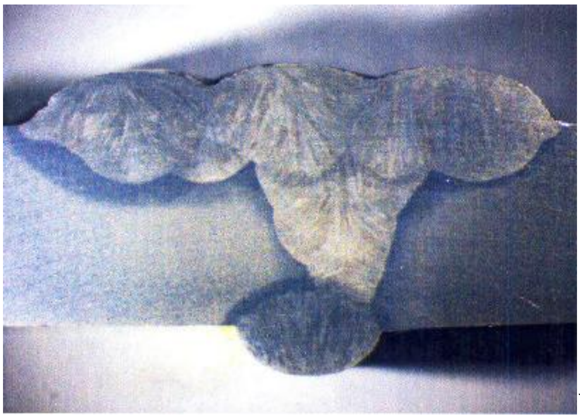

Figure 8. Macrostructure of TIG welded AISI 430 Metals.

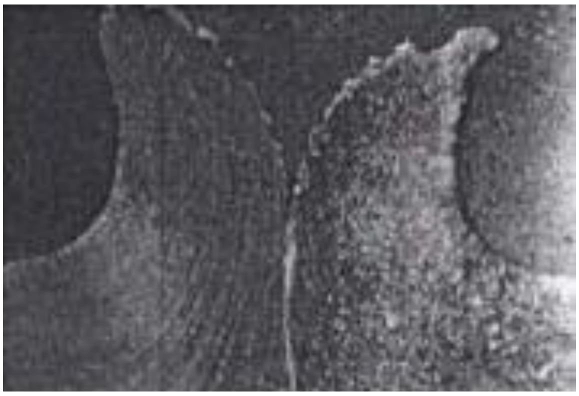

Figure 9. Macrostructure of FW welded AISI 430 Metals.

5. Microstructure

In the MIG and TIG welding process rapid heating at a temperature of 750ºC, the microstructure of the Ferritic stainless steel nearer to the weld portion shows indication of carbide precipitation is shown in figures 10 and 11.The microstructure of the weldment is not homogeneous and variation in structure found by schaefller diagram is shown in the figure 6. In Stainless steel welding, Schaeffler diagram is helpful for estimating the microstructure of the weld deposit. Schaeffler diagram contains chromium equivalent equations in X-axis and nickel equivalent equations in Y-axis. Ferrite raising elements are included in the chromium equivalent equations and austenite raising elements included in the nickel equivalent equations [16]. In this equation nitrogen element not included in nickel equivalent equations even as a strong austenite promoter. So it has been simply incorporated into the diagram at a constant value of 0.06wt%.The chromium and nickel equivalents are calculated to predict the microstructure of the weldment by following equations.

Cr-Equivalent = [%Chromium + %Molybdenum + 1.5%Silicon + 0.5%Niobium]
Ni-Equivalent = [%Nickel + 30%Carbon +0.5%Manganese]. [17]
For base metal AISI 430
Cr-Equivalent = [16.38 + 0 + (1.5x0.41) + 0] = 16.995
Ni-Equivalent = [0.46 + (30x0.13) + (0.5x1.58)] = 5.15
Filler metal for MIG Welding (AISI 347)
Cr-Equivalent = [17 + 0 + (1.5x1) + (0.5x0.5)] = 18.75
Ni-Equivalent = [12 + (30x0.08) + (0.5x2)] = 15.4
Filler metal for TIG Welding (AISI 308)
Cr-Equivalent = [21 + 0 + (1.5x1) +0] = 22.5
Ni-Equivalent = [12 + (30x0.13) + (0.5x2)] = 16.9
As per Schaefller diagram for MIG welding weld metal structure consist of 10% Ferrite and remaining Martensitic & Austenite. TIG Welding concern 10% Ferrite and 90% Austenite structure obtained. In friction welding microstructure obtained is same as that of base metal.

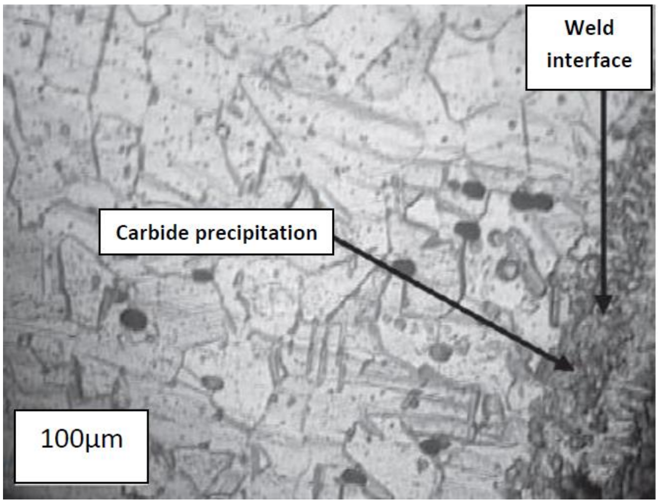

Figure 10. Microstructure of MIG Welded AISI 430.

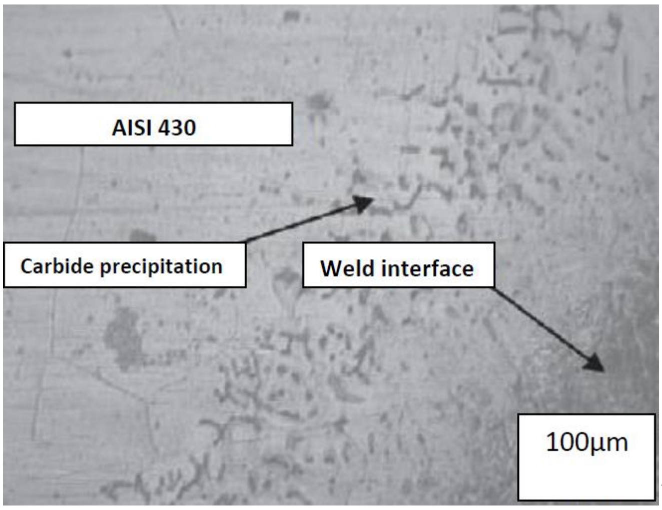

Figure 11. Microstructure of TIG Welded AISI 430.

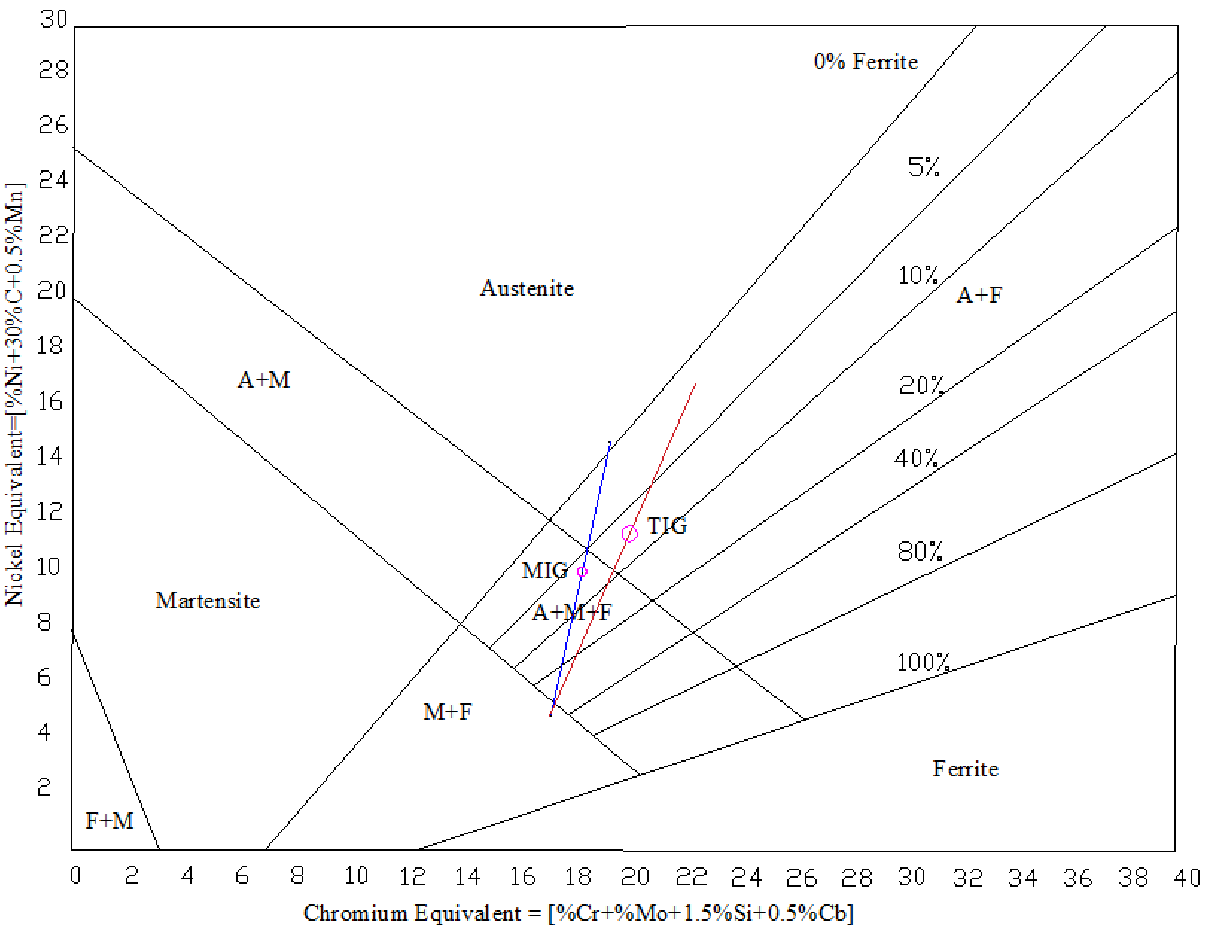

Figure 12. Schaeflller diagram for TIG and MIG welded AISI 430.

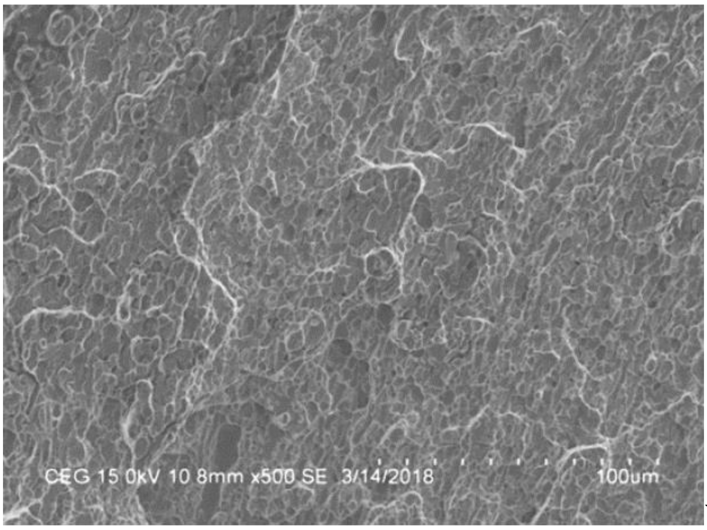

Figure 13. Microstructure of Friction Welded AISI 430.

The microstructure of fractured surface of friction welded AISI 430 by scanning electron microscope shown in figure 13.The fracture takes place in the weld interface and coarser Ferritic features were observed. In addition to that well developed grain boundaries and extensive grain growths are noticed in the fracture surface.

6. Conclusions

1. Good tensile strength obtained by MIG, TIG and FW welding techniques for AISI 430 Ferritic stainless steel.
2. Maximum ultimate tensile strength obtained by MIG welding techniques which gives maximum of 580MPa which is 3.57% greater than base metal compared to TIG and Friction welding.
3. The microstructure of the weldment by TIG and MIG welding is heterogeneous but homogeneous structure obtained in friction welding.
4. The microstructure of the weldment obtained MIG Welding is combination of austenitic, Ferritic and martensitic but TIG welding is austenitic and Ferritic. There is evidence of carbide precipitation which tends to seriously impair the corrosion resistance.
5. The fracture surface of the weldment by friction welding is homogeneous and free from carbide precipitation and other defects.
6. The macrostructure shows diffusion is more in the case of MIG welding as compared to weldment by TIG and Friction welding.

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Design and Analysis of Biceps and Triceps Muscle Strengthening Structure

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Abstract

The field of sports engineering is a relatively new discipline of engineering. It connects two very different domains: engineering and sports. Engineers concerned with sports design build customized equipment related to a sportsperson's needs and also measure the sportsperson's performance, the equipment's effectiveness, and analyze how the two interact. Engineering, along with technology today, is playing a key role in not merely enhancing the sportsperson's performance, but in making fitness more safe and attractive. In this study, an exercise regimen is proposed for improving the strength of biceps and triceps of a sportsperson, followed by a proposed structure (equipment) for executing this regimen. The design of this structure is validated using theoretical calculations and simulations on ANSYS software.

1. Introduction

In the last few decades, sports engineering, a relatively new engineering discipline, has made much progress in research. In technical and scientific terms, it is a field which applies engineering concepts to solve the problems associated with sports equipment design, structure and development which are used by the sports professionals to enhance their performance (Taha et al., 2013). In this field, the sports engineers use raw material and technology to develop sports equipment as per the demands of an athlete.

Sports equipments are selected based on their design, unique features, and context of use. The sports equipment is designed with an idea to create new equipment or upgrade the existing equipment. The present-day improved material technology and processing have made a significant impact on the materials, equipments, and designs (Jenkins, 2003).

The quality or state of being fit defines fitness. Physical exercise involves planned, structured, and repetitive actions with an objective to improve the physical fitness (Mandolesi et al., 2018). The advent of technology into the sports field has enabled sports engineers to improve the performance of athletes by applying new technologies. In this regard, strength training is essential for athletes, army professionals, body builders, and for many other individuals who are either recouping from any type of injury or wish to attain a certain level of fitness. Specific work routines are decided to strengthen an isolated muscle group or a set of muscle groups. Exercise equipment should be made in a way that it encourages people, including those who use the equipment casually. It must require less manipulation, and must be designed so as to avoid injuries.

Any kind of physical exercise is essential for the body and mind. In this study, a novel training routine is presented for improving fitness, followed by the design of the equipment for carrying out this routine. In this study, the psychological and biological aspects of physical exercise are not covered. The study proposes a design for a simple muscle strengthening structure for the proposed exercise routine using simple materials. A blend of sports science and engineering is used to design the structure.

2. Literature review

Wilson et al. (2017), in their research methodology, proposed the development and validation of sports equipment design through four steps. According to the authors, sports design process model is a cyclic process with two major activities: the user involvement and design review. The initial step is the research, followed by conceptual design, design development, and final design refinement. Throughout this process, the user is involved in exploration, evaluation and feedback, and testing of the product. This was the first proposed sport design process model detailing the process, and it highlights the importance of user-focused design processing of equipment. According to Alwasif (2019), in parallel bars strength training, the nine-week program involving 20 min on parallel bar once a week improved the performance in terms of increased rates of the execution quality in gymnasts. This routine, though not specific to any muscle, suggests that the use of operating muscle groups improves the physical characteristics and technical performance of the gymnasts.

Using surface electromyography (EMG), Dickie et al. (2017) showed that among the different grip pull exercises, namely, supinated grip, pronated grip, neutral grip, and rope pull up exercises, the pronated grip pull exercise had a significantly greater peak muscle activation and average rectified variable muscle activation of the middle trapezius when compared to the neutral grip pull-up. Likewise, muscle activation of brachioradialis, biceps brachii, and pectoralis major was higher in the pull up exercise in concentric phases. Bagchi (2015) showed that performing a repetition of four different freehand exercises, i.e. vertical dips, wider grip vertical dips, back dips, and diamond push-ups, the muscle activation of triceps brachii was higher in all except diamond push-ups; and vertical dips was more effective in activating the primary mover (triceps brachii). Likewise, activation of pectoralis major was more effective in wider grip vertical dips.

Calatayud et al. (2014) showed that push-ups, using different suspension devices, activates different upper extreme and core muscles of the body. Maximum activation of muscles such as triceps brachii, upper trapezius, anterior deltoid, clavicular pectoralis, rectus abdominis, rectus femoris, and lumbar erector spinae was found when the pulley system was used. The suspended push-up with a pulley system showed greatest activation of triceps brachii, upper trapezius, rectus femoris, and erector lumbar spinae muscles. Likewise, pectoralis major and anterior deltoid muscles were activated when standard push-up or a parallel band system were used. The study suggested that instead of standard push-ups on the floor, suspended pushups must be performed to increase core muscle activation. The pushups performed with the 50% palmar width resulted in greater activation of pectoralis minor, triceps brachii, and infraspinatus muscle activities (Kim et al., 2016). Saeterbakken et al. (2017) worked on selective activations of muscles as a result of bench press variations involving 6 RM. Based on EMG activity, a significant activation of lower triceps brachii activation in flat, inclined, and declined bench position, and activation of greater biceps brachii activation in the inclined bench was observed. The study suggested that a wide grip and a flat bench position gives greater muscle activation when 6-RM loads are used.

Some issues merit consideration while designing the geometry of its structure: (i) Topological aspects, which pertain to the quantity and connectivity of its components, (ii) Shaping aspects, which relate to the positions of its structural joints, and (iii) Size aspects, which concern the cross-sectional geometries of its members (Kicinger et al. 2005). Specifications for all structural aspects generally relate to three key phases of the flow of engineering design: concept stage, development stage, and the detailing stage (Pahl and Beitz, 2013). The topological structure is usually established at the concept design stage and relates to the functional needs and structural aesthetics. On the other hand, the shape of the structure including the sizes of the members is evaluated in the stages of development and detailing, respectively.

Selection of materials and process-related data is required at all designing phases. The identification of materials at the initial designing phase require data approximations for every process and material, whereas selecting materials at the last detailing phase requires the consideration of exact and detailed information of a few selected processes and materials (Ashby, 2010). Among the vast plethora of materials and production processes, the right choice requires to be made for shaping, joining and finishing the equipment. Engineers will either make an assumption regarding a material before the optimization of the geometry, or opt for the most suitable material for a structure's geometry that is available already. However, both these methods do not guarantee the best combination of material and geometry. Several optimizing techniques have been presented in the literature for the integration of geometric design and selection of materials (Edwards, 2005).

The fitness apparatus available today consists of commercial and home equipment. Organizations catering to these sectors generally split their products in three specific yet different product categories: (i) cardio-based systems, which are utilized for endurance exercises, such as treadmills, (ii) resistance-based systems, which are utilized for power and strength exercises, such as benches and weights, and (iii) related accessories such as parallel bars, dumbbells, and the like (Caine and Yang, 2007).

In India, the fitness products and equipment market is predicted to increase at 15% in the period 2017–2023. The number of gymnasiums and health centers are increasing, and so are governmental attempts for encouraging fitness, which are spurring the already growing Indian fitness product market. The Indian government in 2017 had promulgated that all its offices needed to provide gymnasium facilities. Additionally, the HRD and Training departments are encouraging gymnasium facilities in its offices through monetarily compensating the offices. Also, increasing preferences of people for being physically fit in the face of increasing lifestyle illnesses is spurring the market's growth further. In 2016, it was seen that stationery bicycles and treadmills were the highest selling cardio-training products (Business Wire, 2017).

3. Methodology

Any type of physical training results in changes in the ultra-structure of the muscles, muscles strength and the performance. Changes in different muscle areas and protein in the muscles results in a change in the muscle structure. First, the proposed training routine is presented.

3.1. Biceps and Triceps

The biceps, also biceps brachii (Latin for 'two-headed muscle of the arm'), is a large muscle that lies on the front of the upper arm between the shoulder and the elbow. Both heads of the muscle arise on the scapula and join to form a single muscle belly, which is attached to the upper forearm. While the biceps crosses both the shoulder and elbow joints, its main function is at the elbow where it flexes the forearm and supinates the forearm.

Triceps, also known as triceps brachii, is often referred to as a 'three-headed muscle'. The three muscle bundles, namely, the lateral head, the long head, and the medial head, make up the triceps and are the only muscles that lie along the posterior humerus (upper arm). Triceps function as extensors and help increase the angle between the forearm and the upper arm. Triceps are the muscles exerted for the pushing action (Landin et al., 2018). To develop the triceps, one needs to focus on exercises that push weights away from the body, and dips are a popular exercise to strengthen triceps along with deltoids and pectoralis muscles (Goodson, 2017) .

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3.2. Biceps Program

With a focus to improve the body form and build stabilized strength, the biceps program involves 5 workouts per week, with at least 2 rest days between workouts for a duration of 3 to 4 months. To build the strength and muscle, both, a repetition of 10–12 repetitions per set is suggested, depending on the subject's exercise stamina, and whether the subject is at a beginner, intermediate or advanced level. The bicep exercise is shown in Figure 1. The push up is done in a position where feet are positioned on the central rod, and the hands are positioned on the small inverted rods, ensuring that hands and shoulders are apart, and the trunk is in a rigid straight position. In the first stage of the push up, the elbows are fully extended, and when the subject descends down towards the ground, the elbows are flexed until the upper arm is in line with the trunk. This is repeated as given in Table 1.

Figure 1 Biceps exercise

Table 1 Biceps exercise program

Exercise	Sets	Repetitions	Rest
Push Ups (Beginner)	3	12-15	2 min
Push Ups (Intermediate)	4	18-20	3 min
Push Ups (Advanced)	5	20-22	4 min

3.3. Triceps Program

Similarly, a triceps program involves dips with a frequency of 5 workouts per week, with at least 2 rest days between workouts for a duration of 3 to 4 months. For each category of participants, a minimum of 10-12 repetitions is proposed for building their muscle strength. For this particular exercise regimen, the participant has to keep the feet supported by the heel on the second rod, with hands backward on the small inverted rods (as if sitting on a ground in a dipping position) (Table 2). In the initial stage, the elbows are extended, and when going down towards the ground, the elbows are flexed such that the folded elbow and shoulder are at the same height (Figure 2). A dip exercise trains the upper body as well as the core.

Figure 2 Triceps exercise

Table 2 Triceps exercise program

Exercise	**Sets**	**Repetitions**	**Rest**
Dips (Beginner)	3	12-15	2 min
Dips (Intermediate)	4	18-20	3 min
Dips (Advanced)	5	20-22	4 min

It is to be noted that beginners have muscles that are ready and willing to grow as long as they are challenged. Each set is stopped when the exercise form starts to slip, or when it is felt that one might fail on the next repetition. As many repetitions as possible are done for each set.

3.4. Proposed design structure

Based on the exercise regimens, a structure is proposed (Figure 3). An inverted U shaped structure, 40' long and 5' high is grouted on a cement concrete prepared bed. This structure is supported by seven vertical supports made of the same material, again grouted on the concrete surface. Another 40' long GI pipe is welded to this structure 2' above the concrete surface. All joints are welded firmly on all sides. Located 2.5' away from this axis are 24 inverted U shaped hand supports, placed at repetitive intervals of 1.5' -1.0' -1.5' from each other. These hand supports are 1.5' long and 2' high. They are made of steel and are 2' ' thick.

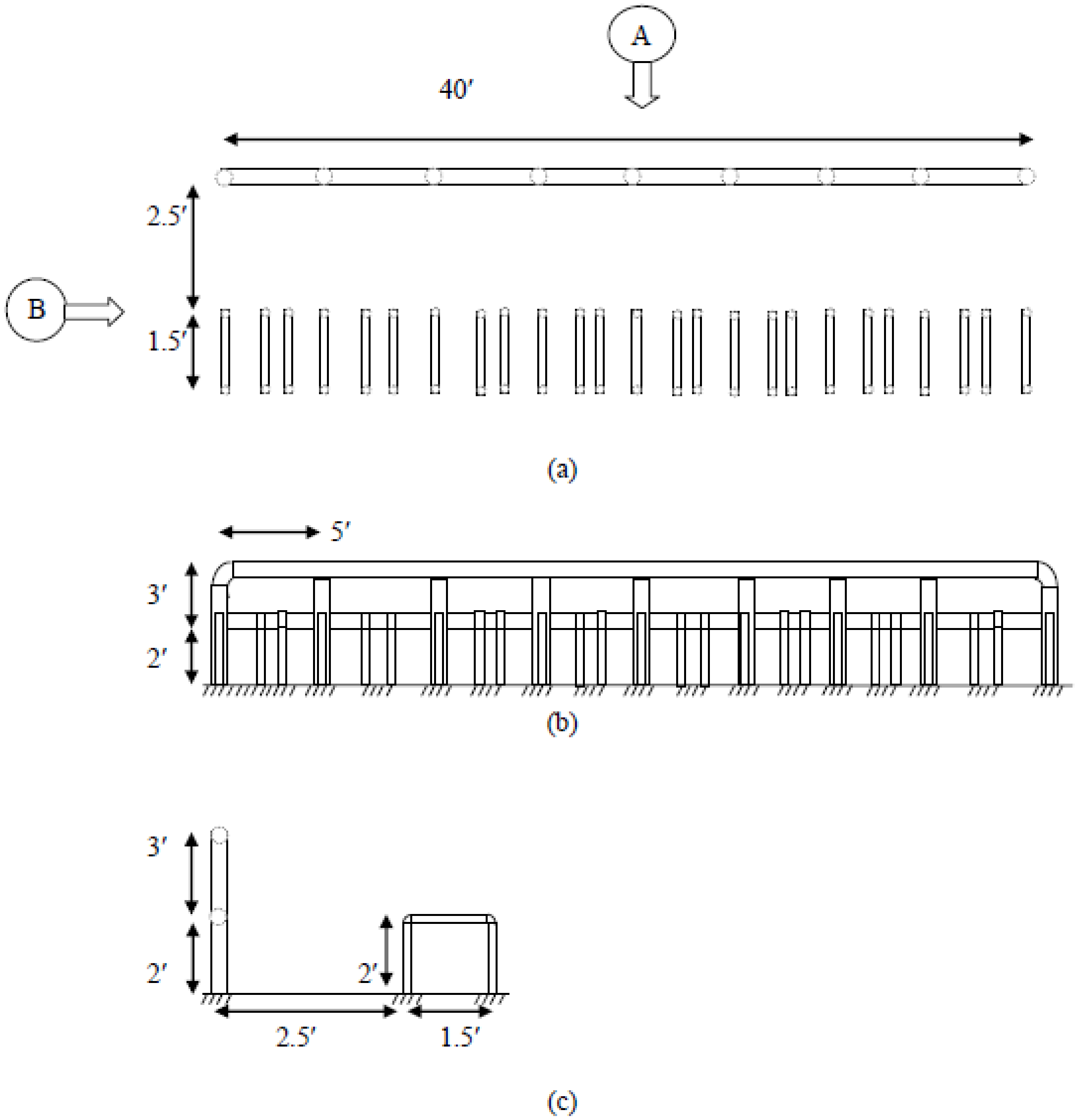

Figure 3 Proposed structure for the exercise regimen. (a) Plan of the structure (b) Elevation (view from A) (c) Elevation (view from B)

3.5. Calculations for beam deformation

For calculating deformation, the beam is considered as being supported at 8 points. Each section between two points is depicted in Figure 4. It is assumed that the user exerts a point load of F=900 N on the beam as shown. This point load is first exerted on the left, center and right of the beam section.

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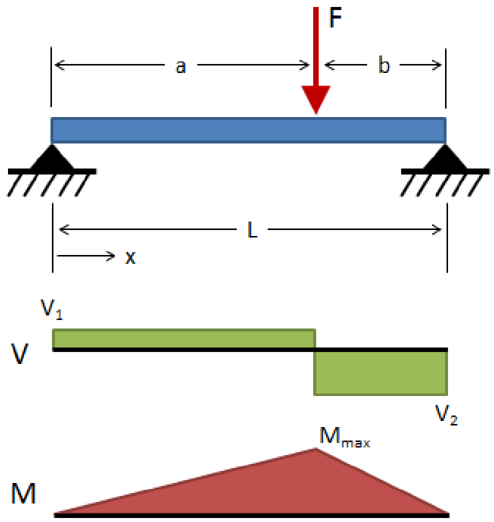

Figure 2 Beam loading diagram

The formulae for beam deformation and location of maximum deformation are as follows (Timoshenko and Young 1968):

$$\delta_{\max} = \frac{Fb(L^2-b^2)^{3/2}}{9\sqrt{3}LEI} \text{ at } x = \sqrt{\frac{L^2-b^2}{3}} \qquad (1)$$

where E is the Young's Modulus, I the Moment of Inertia, and L and b are as shown in Figure 2.

Moment of Inertia $I_y = \pi\,(d_o^4 - d_i^4)\,/\,64$ (2)

4. Results

The results section is divided in two subsections. First, the calculations for deformation are presented based on equations 1 and 2. Next, the results based on ANSYS simulation are presented.

4.1. Calculated deformations

Three cases are presented as follows:

Case 1: **Load located at the center**

Here, L = 1524 mm, F = 900 N, b = 762 mm, d_o = 26.75 mm, and d_i = 23.25 mm.

$E = 3\times10^{11}$ N/mm^2

By substituting these values in equations 1 and 2, one gets

$\delta_{max} = 1.762\times10^{-8}$ mm at x = 762 mm.

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Case 2: Load at right corner

Here, L = 1524 mm, F = 900 N, b = 381 mm, d_o = 26.75 mm, and d_i = 23.25 mm.

$E = 3\times10^{11}$N/mm^2

By substituting these values in equations 1 and 2, one gets

$\delta_{max} = 2.203\times10^{-8}$ mm at x = 852 mm.

Case 3: Load located at left corner

Here, L = 1524 mm, F = 900 N, b = 381 mm, d_o = 26.75 mm, and d_i = 23.25 mm.

$E = 3\times10^{11}$N/mm^2

By substituting these values in equations 1 and 2, one gets

$\delta_{max} = 2.203\times10^{-8}$ mm at x = 582 mm.

4.2. Simulation results

Ansys Mechanical APDL was used for simulation. The code structural problem to be solved is first selected. The element type describes the shape of the problem for analysis and characteristic describes the material arrangement.

The following beam properties were selected:

Type - Hollow Spherical Beam

Element Type - BEAM 188

Characteristic - Isentropic (Constant Material Characteristic)

Solution - Linear (Elastic Behaviour of the beam)

Inner Radius = 23.25 mm

Outer Radius = 26.75 mm

The 2-node linear/quadratic beam element in 3-D was selected with six or seven degrees of freedom at each node and which is suitable for both, linear and non-linear applications.

Also, the following material parameters were chosen (Table 3).

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Table 3 Material properties

Material Property	**Value**
Point load (Newton)	900
Young's Modulus (N/mm)	3×10^{11}
Poisson Ratio	0.3

Case 1: Load located at Centre

The loading pattern is shown in Table 4. Figure 5 shows the simulated loading diagram.

Table 4 Loading pattern for case 1

Distance from the Center (mm)	**Load (N)**
0	
762	900
1524	
2286	900
3048	
3810	900
4572	
5334	900
6096	
6858	900
7620	
8382	900
9144	

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9906	900
10668	
11430	900
12192	

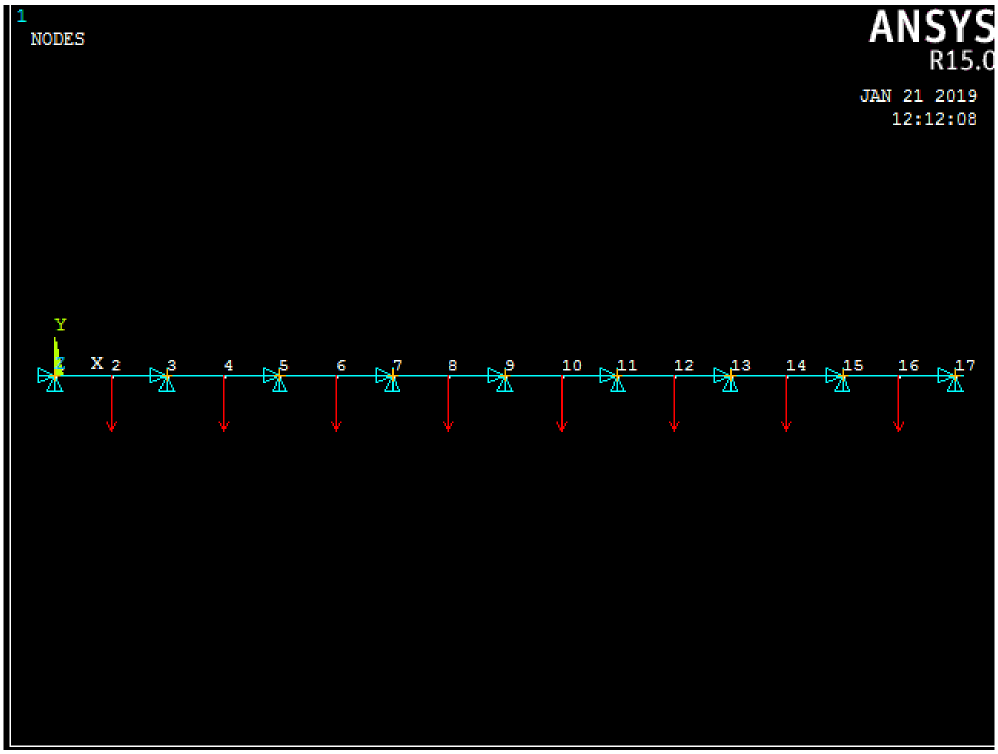

Figure 5 Simulated load at centre

The resulting beam deflection is shown in Figure 6.

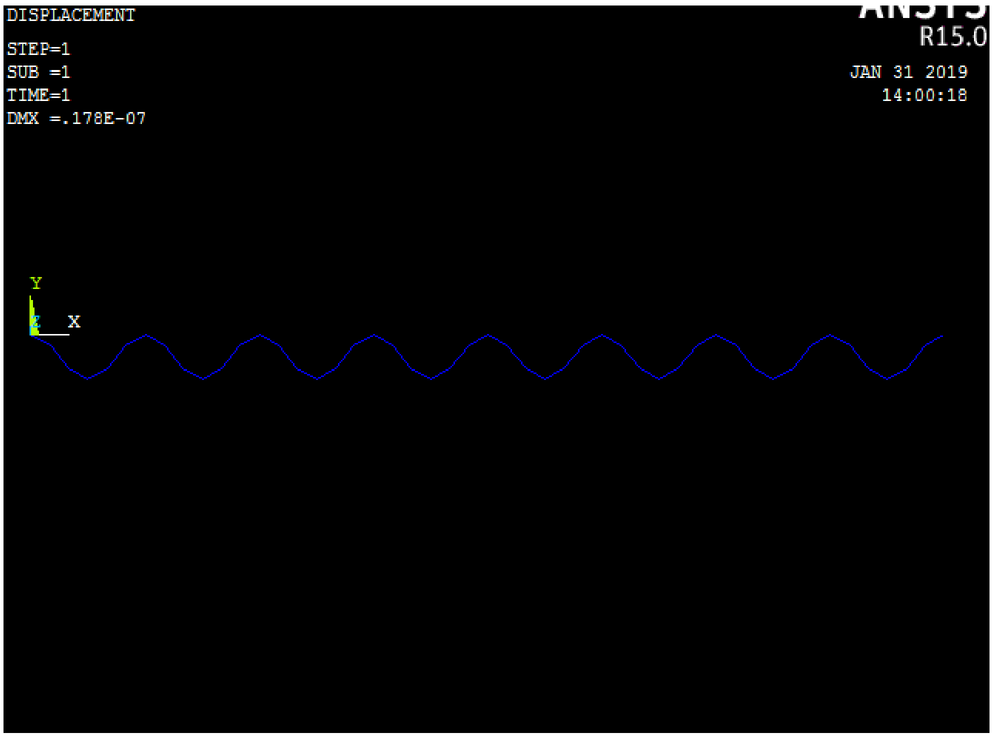

Figure 6 Case 1: beam deflection

Case 2: Load located at right corner

The loading pattern is shown in Table 5. Figure 7 shows the simulated loading diagram.

Table 5 Loading pattern for case 2

Distance from the Centre (mm)	**Load (N)**
0	
381	900
1524	
1905	900
3048	
3429	900
4572	
4953	900
6096	
6477	900

7620	
8001	900
9144	
9525	900
10668	
11049	900
12192	

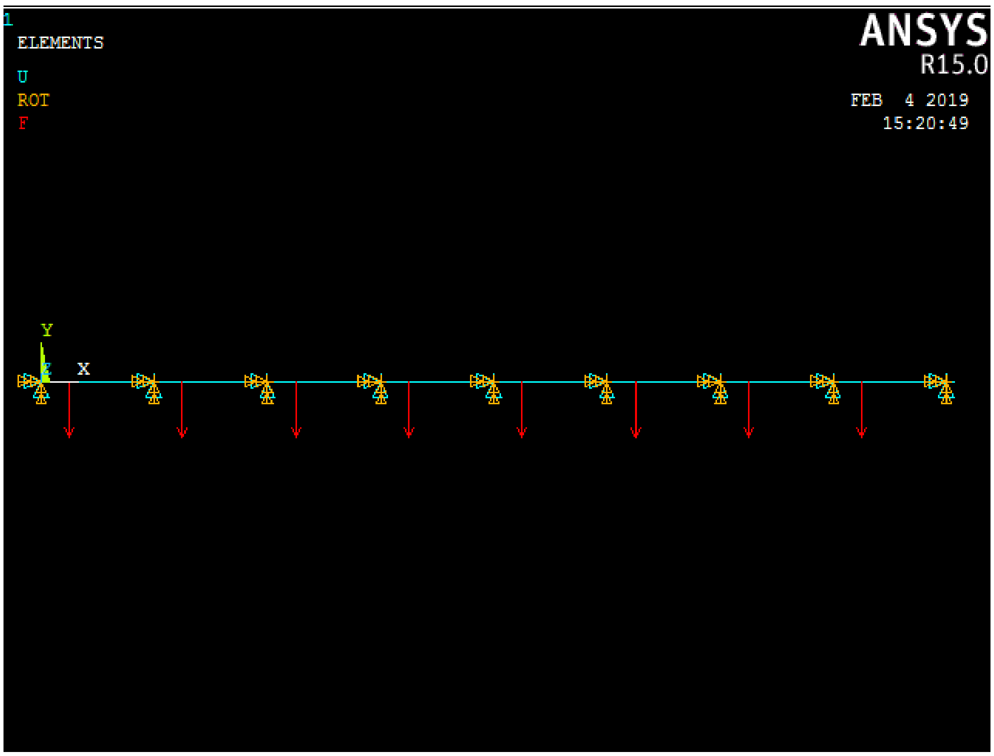

Figure 7 Simulated load at right corner

The resulting beam deflection is shown in Figure 8.

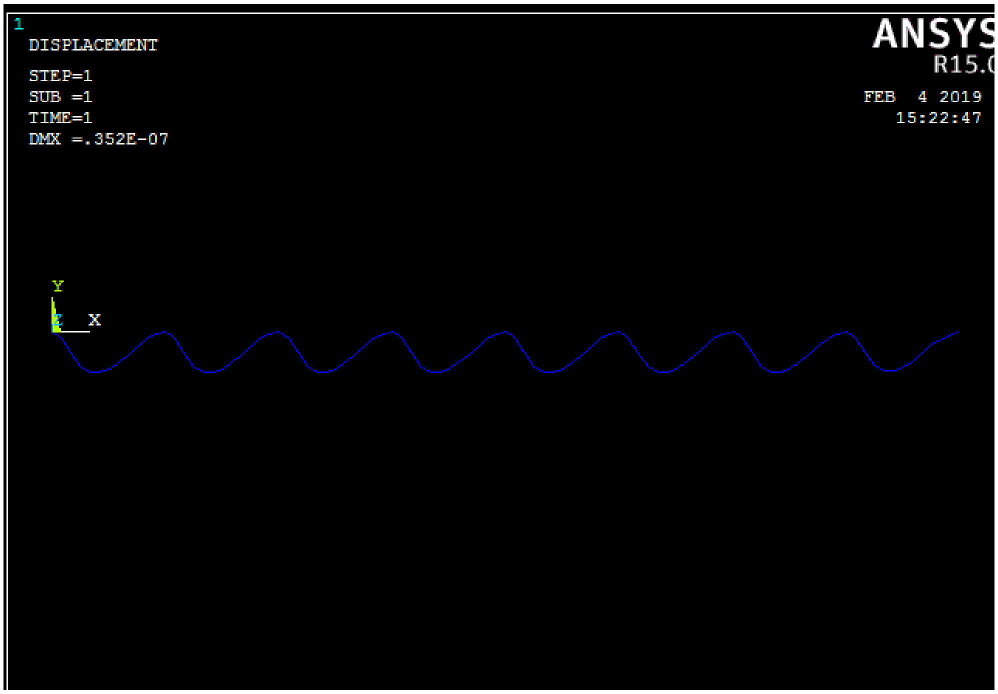

Figure 8 Case 2: beam deflection

Case 3: Load located at left corner

The loading pattern is shown in Table 6. Figure 9 shows the simulated loading diagram.

Table 6 Loading pattern for case 3

Distance from the Centre (mm)	Load (N)
0	
1143	900
1524	
2667	900
3048	
4192	900
4572	
5715	900
6096	
7239	900

7620	
8763	900
9144	
10287	900
10668	
11811	900
12192	

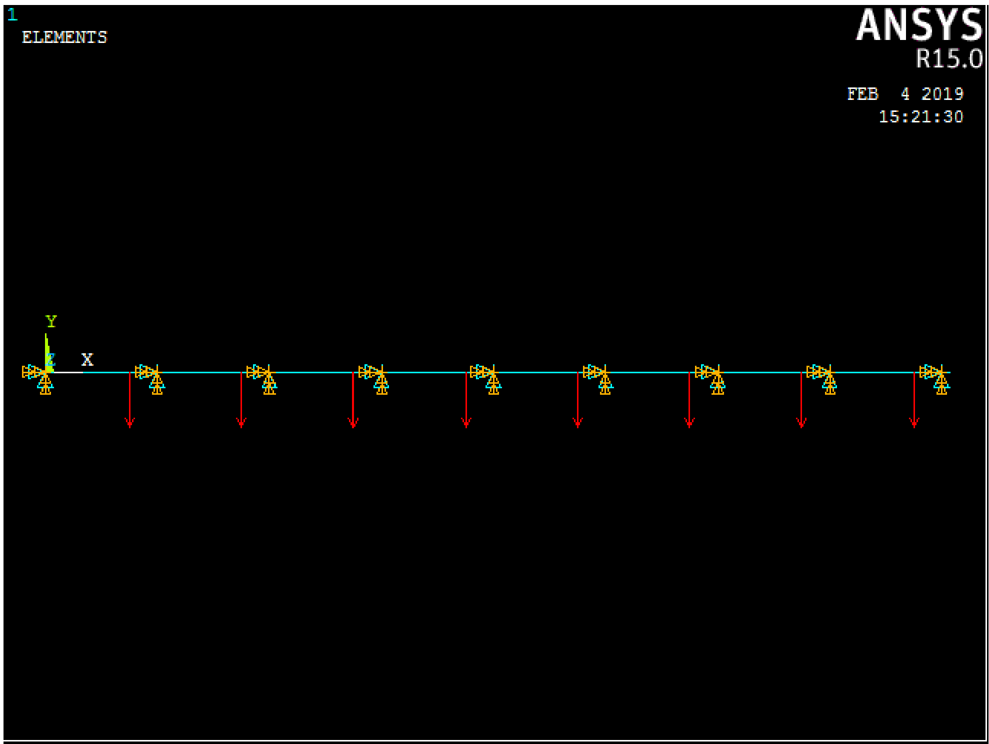

Figure 9 Simulated load at left corner

The resulting beam deflection is shown in Figure 10.

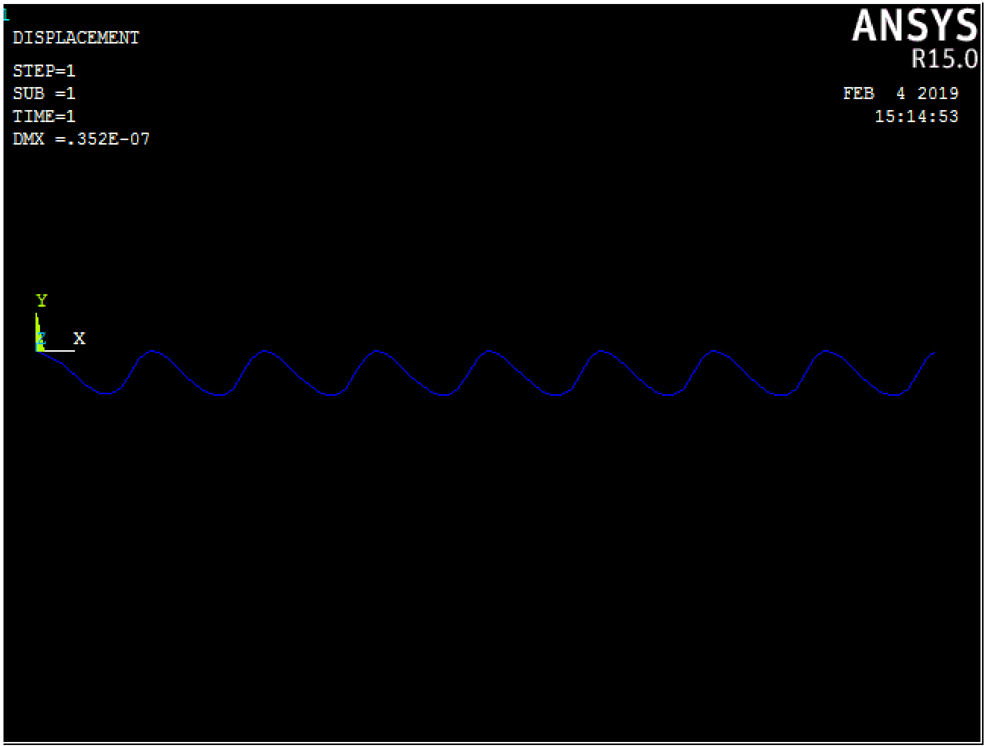

Figure 10 Case 3: beam deflection

4.3. Analysis

The summarized results of the theoretical calculations and simulations are presented in Table 7.

Table 7 Summary of results

Loading location	**Maximum deflection: Theoritical (mm)**	**Maximum delection: Simulated (mm)**
Load located at the center	1.762×10^{-8}	1.78×10^{-8}
Load at right corner	2.203×10^{-8}	3.52×10^{-8}
Load located at left corner	2.203×10^{-8}	3.52×10^{-8}

It is seen from the above table that the results of the theoretical calculations and simulations agree with each other, i.e. there is a very little difference of value.

As per codes of practice, the deflections must not exceed $\frac{1}{250}^{\text{th}}$ times the length of the beam (1524 mm) between the supports, and the results clearly indicate that the deflections are well within this limit.

Thus, the structure meets the requirement the proposed exercise regimen.

5. Discussion and conclusion

There is a constant challenge while designing fitness products and systems, i.e. the need for lesser weights, reduced costs, and good performance. The main aim of an engineer's design is the definition of the component dimensions, including the material selection for its construction in order that the product can carry out its functions in an acceptable and economical manner (Edwards, 2005). An optimized product design includes the selecting of product geometry and production processes for meeting requirements for design and maximizing its performance while keeping it economical (Ashby, 2010).

In keeping with the above principles, in this study, the sports structure has been designed using GI pipes. The GI pipe is an easily available material, with lesser cost and required flexibility. This makes the structure economical to produce. The design is simple comprising of only welded joints, hence is easy to manufacture. Also, eight people at a time can use the apparatus for exercise. This makes it ideal for use in establishments which train large groups of people.

The maximum deflection was seen to be 3.52×10^{-8} mm. This is very much within the limit for failure. Thus, it is seen that this fitness equipment meets the requirements of the proposed fitness regimen. The engineering design is, thus, validated for safety against failure.

Therefore, the proposed structure meets the design requirements, is simple to manufacture, and is economical, making it ideal for implementation in the Indian context.

6. Limitations of this study and future research

The analysis of muscle morphology, muscle activation, and performance is not evaluated in this study. The measurement of these variables will help to expand the understanding of the muscle strengthening program and the designed structure.

Changes in the muscles depending on the specificity of the training were established. In a pilot study, the authors suggested programs to strengthen the biceps and triceps, and it was found to be effective in increasing the muscle strength and the performance. The future research will include the estimation of muscle area and activation in the control and experimental group performing these programs at pre-intervention and post-intervention. This model and the program could be used as a reference to strengthen

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the bicep and tricep muscles. This would also enable the testing of the involvement and activation of other muscles, too.

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Smart Industry Monitoring and Controlling System Using IoT

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Abstract

Air pollution in an ecosystem has proliferated industrial automation. This dissertation concentrates more on industrial automation and has design an embedded device with sensors to monitor and control the toxic gases in industries. This entire prototype is an excellent result for observing the toxic gases in industry and generates information by using data acquisition and transmission of data."Internet of Things (IoT)" is a important technology behind this and it provide platform to bring together all the devices in the world to the internet. In this dissertation, the parameters monitored are temperature, humidity and gas leakages in industries. The sensor senses the parameters and uploads these data to the cloud with the help of NodeMCU. If observed gas level is above the threshold which is the safety limit of operation, the first alert is intimated from the Google cloud and the controlling action carried out (ie) automatically close gas leakage valves and then industry will take immediate step to control pollution. Or else, the second alert message is sent through Electronic mail (e-mail) to restore the safe limit, as government play role to power outage in the industries. Cloud is used to store the sensed data, which is then transmitted and processed.

Keywords: Air pollution, Toxic gases, ECO-system, ESP8266 and IoT.

1. Introduction

In the recent years wireless technology and IoT grasped the most industrial area especially automation and control has increasing for need of upholding various sectors. Healthcare has prime importance in our day to day life. This paper reviewed about new industrialization with ESP8266 and arduino UNO. Indoor Air Quality (IAQ) is highly worsens industrial environments, which then spreads from indoor to outdoor, creating a large scale effect around the industrial areas. Long term and short term effects caused by Air pollution causes the people to concern about the air they breathe. The effect of air pollution from industry is monitored scarcely. Our aim is to monitor the air pollution from the heavy industry which leads to undesirable effects on the health of human beings and also affects the environment. Pollution level in comparison to the ambient air quality standards can be done by using monitoring. Standards are requirements which set the target for pollution level and used as a bottom line to compare with actual pollution levels and rate them. To protect the people against extreme air pollution. Robust monitoring systems are necessary to alert people and initiate actions.

2. Review of Related Literature:

Kavitha.B.C et al. (2019), insists on using intelligent sensors for pollution monitoring. Collected data from the sensors are sent to the Google cloud makes it possible to monitor the air pollution from anywhere in the world. In case of threating levels of air pollution, alerting is used. This is used in industry and the pollution by vehicular emissions. Rajalakshmi.R et al. (2019), Observes the toxic gases present in the air to ensure the safety of the people in that environment and make it available at any place in the world for monitoring. The composition of chemicals in air like carbon monoxide, LPG, methane and flammable gases is monitored using sensors and this data is sent to the cloud server, which is then represented pictorially for better understanding of the statistics.

Rupali et al. (2018), cares for home and industrial safety using fire and gas detection systems. This system detects the leakage of gas and fire using sensing circuit, which is then controlled by microcontroller which in turns triggers the alarm system to alert the leakage of gas and fire. Using GSM modems, SMS are being sent to notify the user. In addition, it is designed with mechanism to sprinkle the water using water sprinkler when there is a fire or gas leakage.

MQ-6 and MQ-9 used as gas sensors to detect the gas leakage. IR flame sensor is used for fire detection, which detects the fire and notifies the user using SMS. Manish Verma et al. (2018), uses microcontroller based system to investigate about the toxic gas detection and alerting system. LCD display is used where the levels of hazardous gases like LPG and propane was displayed each second. Authorized person is notified with email and also using alarm generation mechanism. This automated detection and alerting mechanism helps to resolve the problem as soon as possible. Angelica Nieto Lee et al. (2018), this paper focuses on integrating all the contextual data, to provide accurate and relevant information as per the need. System information that already exists but has not been integrated into the monitoring system like 3D models and manuals. It is context aware industrial monitoring systems, which provide information based on system state, environmental conditions and functionalities of the devices in that environment. Ishwarya et al. (2018), insisted on automation of many small tasks around us using Internet of Things (IoT) in order to improve the quality of living. IoT is used for enhancing existing safety standards, using automation process. Gas leakages in open or closed areas can prove to be dangerous and fatal. Traditional gas leakage systems can able to detect the leakage but cannot able to alert the user. Alerting System can be established to alert the authorized person and to perform the data analytics from the obtained readings.

Kannappan.A et al.(2017), provides a way to avoid industrial accidents, using arduino UNO. Temperature, gas sensor, radiation sensor, is connected to arduino UNO board. The data from the sensor is stored in the server which is then processed to indentify the hazardous levels, which provide a concern towards the people working there and staying there.It is also notified to multiple user regarding radiation and gas leakage. A sound alert is giving to notify all the people working in the industries regarding the excessive harmful levels of gas and radiation. Excessive level of gas and radiation is notified to internet website and also indicated in android app. Mohammed.Y et al. (2017), uses smart technology on the oil and gas industrial sectors for optimization of various upper, middle and lower sectors. Internet of Things play a vital role in the development of wired and wireless systems In drilling of oil, monitoring plays a vital role in safety, productivity and improving the production life of oil wells. This paper is intended to provide an intelligent monitoring system for reliable monitoring of oil wells using smart IoT objects. Temperature, Pressure, concentration of gases, is sensed using the smart IoT objects and provide the gathered data to the central controller which in turn used to detect the catastrophic failures and un favorable conditions.

3. Proposed System:

The figure 1 below shows the block diagram and prototype of the proposed system. The components used to design the hardware is as follows,

- Arduino UNO
- Semiconductor sensor (MQ6 & MQ7)
- ESP8266
- Relay
- Power supply

MCP3008 is an analog to digital convertor. Analog values from the sensors are given to MCP3008, which is an 8 channel ADC, that converts the analog data to digital data which is then sent to NodeMCU. The parameters are monitored using DHT11, MQ-6, and MQ-7 sensors. The sensor senses their parameters regarding the temperature, humidity and gas level and uploads these data to the cloud with the help of WiFi device (NodeMCU). If the level of the gas reaches above the normal level, the first alert is intimated from the Google cloud as it is automatically closes gas leakage valve and then industry will take immediate step to control pollution. Or else, the second alert message is sent through Short Message Service (SMS) to restore the safe limit intended so and as government play role power outage in the industries.

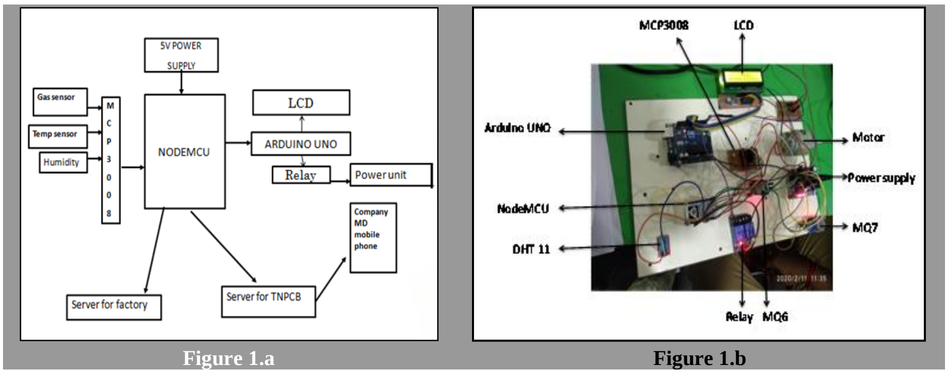

Figure 1.a Figure 1.b

Figure 1. Block diagram and prototype of the proposed system

4. Result and Discussion:

We are going to test our prototype for different cases are discussed below. For our analysis Gas-1 represents carbon monoxide (CO), Gas-2 represents Isobutane, Propane, Liquefied Natural Gas (LNG) and Methane. Temp represents temperature. Humi represents humidity. Status represents either normal or emergency based on the industrial gas leakage level.

Analysis for Gas-1:

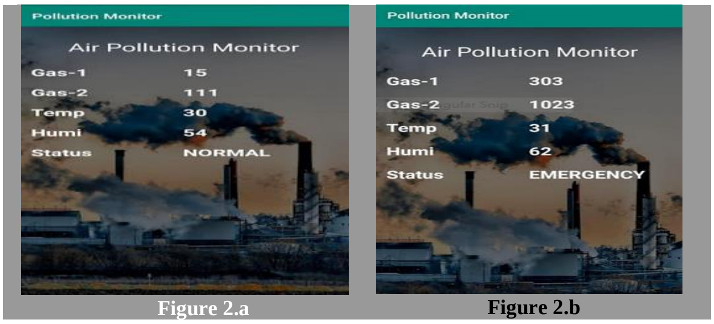

Figure 2.a Figure 2.b

Figure 2. Output of Gas-1

Case1:

In the figure 2.a, the permissible level of Gas-1 is below 300. In this case, Gas-1 does not reaches permissible level, so it is not harmful to the environment. Hence the status is normal.

Case 2:

In the figure 2.b, the permissible level of Gas-1 is above 300. In this case, Gas-1 reaches above permissible level so it is harmful to the environment. Hence the status is emergency.

Analysis for Gas-2:

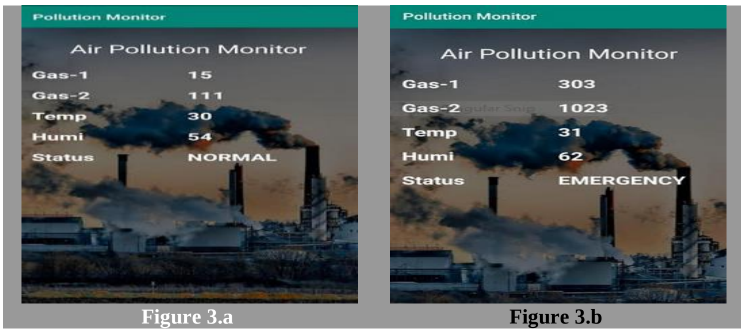

Figure 3.a Figure 3.b

Figure 3. Output of Gas-2

Case1:

In the figure 3.a, the permissible level of Gas-2 is below 300. In this case, Gas-2 does not reaches above permissible level so it is not harmful to the environment. Hence the status is normal.

Case:2

In the fidure 3.b, the permissible level of Gas-2 is above 300. In this case, Gas-2 reaches above permissible level so it is harmful to the environment. Hence the status is emergency.

Analysis for humidity:

Case1:

The normal level of humidity in the industrial area is about 40-50%. When it exceeds the normal level it is harmful to the environment. In the figure 4.a, the humidity remains in normal level. Hence the status is normal.

Figure 4.a Figure 4.b

Figure 4. Output Gas-3

Case2:

The normal level of humidity in the industrial area is about 40-50%. When it exceeds the normal level it is harmful to the environment. In the figure 4.b, the humidity exceeds the normal level. Hence the status is emergency.

Conclusion:

In this paper smart Industry Monitoring system based on IoT is proposed which can effectively monitor and controls with alert. A prototype based on Arduino UNO was developed which could sense the concentration of gases. The real time data information obtained from the different sensors has been uploaded to Google Cloud which displayed in the LCD. In addition to this other parameters like temperature, humidity was measured. Provision was also made to vigilant the workers in case of any emergency. The system provides consistently and accurate analysis to prevent any case of accidents. This system makes use of Arduino UNO providing cheap solutions for safety. Slight modification of the model enables the user to adapt it to any environment. Predictive maintenance is an upcoming industrial need, for which the proposed model can be improvised. In case of gas leakage the concentration of gas varies from point to point which has to be analyzed. Moreover, the gases diffusing out during leakage may also combine among themselves producing other by products which have to be dealt in detail.

Fututr Scope:

This prototype helps the industrial site from gas leakage deduction and faster resolution of problems afforded by a higher level of expertise focused on control system. This methodology could be applied to monitor distribution network of natural gas as well as industrial, commercial, residential gas pipelines in order to provide a safe operation and to avoid severe human health injuries caused by gas leakages. Proposed solution can act as a automatic vehicle health feed for manufacturer to improve their quality by providing regular vehicle services.

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Design of Optimal Parameter for Solid-State Welding of EN 10028-P355 GH Steel Using gray Incidence Reinforced Response Surface Methodology

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Design of Optimal Parameter for Solid-State Welding of EN 10028-P355 GH Steel Using gray Incidence Reinforced Response Surface Methodology

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Abstract

EN 10028-P355 GH steel is normalized steel used in high-temperature applications including pipes carrying hot fluids. Fusion welding of such class of steels produces a larger heat affected zone, unwanted metallurgical changes and increased hardness in the weld area. The study explores the possibility of using a solid-state welding process (continuous drive friction welding) on EN 10028-P355 GH steel. The experimentation involves an L_{27} orthogonal array with the welding parameters like frictional pressure, forging pressure, friction time, forging time and rotational speed varied in three levels. The quality characteristics observed include the yield strength, tensile strength, axial shortening and impact toughness. The merits of gray theory are combined the statistical analysing capabilities of response surface methodology in an integrated approach of gray incidence reinforced response surface methodology to select the optimal friction welding inputs (frictional pressure-93.94 MPa, friction time-5.22 s, upset pressure-138.14 MPa, forging time-3.58 s and rotational speed-1282.67 rpm). The optimal friction welding inputs were validated with proper experiments, and microscopic images concerned with optimal bond is also analyzed. The study will offer the guiding database to weld EN 10028-P355 GH steel in solid-state using continuous drive friction welding.

Keywords EN 10028 GH steel · Continuous drive friction welding · Response surface methodology · gray theory · L_{27} orthogonal array

1 Introduction

The EN 10028-P355 GH steel finds its widespread applications in pressure vessels and boilers. The high tensile strength and impact toughness of EN 10028-P355 GH steel makes it a primary choice for tubes and pipes transporting hot fluids in heat exchangers. There are concerns in joining EN 10028-P355 GH steel using the conventional liquid state joining processes. The fusion welding techniques are characterized by the presence of a larger heat affected zone (HAZ) and consequent changes in the metallurgy of parent, producing corrosion at grain boundaries on a microscopic scale. This could affect the mechanical properties of joint, which is significant in applications at elevated temperature and stress. Hence, joining EN 10028-P355 GH steel in a solid-state could open up the possibilities of minimizing such unwanted mechanical and metallurgical changes. The temperature involved in solid-state processing is considerably lesser than the melting point of parent material hence producing a meager or zero HAZ. The continuous drive friction welding is a joining process employed to join tubes and pipes of both ferrous and non-ferrous materials. The process involves the generation of heat by mechanical rubbing (rotation) of one part with the other half of the joint. The desired rotational speed ensures a constant and continuous stirring at the weld interface and the applied upset pressure produces a bond with a certain amount of flash. Further the volume of material close to the weld interface alone is subjected to plastic deformation, restricting the axial shortening of joint. In the preliminary stages of the formation of a bond,

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the end of the rotating part was made tapered and inserted into a bore ring made of a material with good thermal resistance [1]. During the process, the plastic flow of material was observed at the joint interface. The mechanism regulating the plastic flow of material at the weld interface was important for controlling the amount of flash produced. A sound joint with a reasonably lesser flash was always desired to reduce axial shortening [2]. The observations patented by United Launch Alliance, Inc., had described the essential improvements in hardware employed to produce joints in solid-state [3]. A self-reacting pin tool was also proposed to eliminate the difficulties experienced in using a rigid and static tool in friction stir welding.

Friction welding was used to produce dissimilar steel joints with reasonably good strength and ductility compared to that of the parent material. The investigation revealed that the susceptibility of the weld area to failure under uniaxial loading as the weld interface was the weaker zone due to increased microhardness. The friction welding inputs including frictional pressure, upset pressure, burn off length and rotational speed were found to significantly influence the mechanical properties of joints [4, 5]. The design parameters in friction welding were varied to study their roles in the strength related aspects. The mechanical tests on joints had revealed a higher hardness in the plastic weld zone, while the microhardness variation was found to be lesser in the parent material [6, 7]. In the joints formed between AISI 4140 and AISI 1050 steels, the temperature rise was observed to play a vital role in affecting the quality characteristics of the bonds. The initial rise in temperature was found to be larger, followed by a steady rise with the continuous rotation, and the joints were formed with zero blank spaces [8]. Austenitic stainless steels known for weldability and corrosion resistance were produced with desirable mechanical properties friction welded at high temperatures [9]. Non-ferrous alloys could also be joined by friction welding and proper selection of process parameters could yield a joint efficiency of 89% in as-welded condition [10]. However, the dissimilar joints formed between aluminum and copper showed poor strength as a result of the accumulation of alloying elements and intermetallic compounds at the weld interface [11].

Generally, the friction welded interface included three different regions: unaffected zone, partially deformed zone and fully deformed recrystallized zone. Most of the microstructural changes were observed in the fully deformed and partially deformed zones [12]. A near-perfect bonding strength, close to that of parent material was possible by selecting proper values of friction time and rotational speed. The temperature distribution in the friction interface was mainly dependent on the welding parameters [13]. High strength nickel alloys joined using friction welding displayed a harder and stronger weld zone due to the formation of precipitates [14]. Dissimilar bonds involving maraging steel and low alloy steel were also formed using continuous drive friction welding. An interlayer of nickel was used as a diffusion barrier to improve the joint strength. The bonds were observed to respond to solutionizing and aging positively during post-weld heat treatment [15]. The tensile strength of steel joints increases with frictional pressure and friction time up to a certain level, but tend to decrease at higher values of these welding inputs. A similar trend was observed with the fatigue strength of joints [16]. Rotational speed and frictional pressure were found to influence the distribution of temperature and plastic flow of material at the weld interface. Optimal values of these welding inputs were observed to produce defect-free joints [17]. Hence, it is observed from the literature that superior quality characteristics of a joint depends primarily on the optimal selection of friction welding parameters like frictional pressure, friction time, upset pressure, forging time, burn off length and rotational speed.

Identifying the proper levels of various friction welding inputs could result in a joint with better quality characteristics. Hence, finding the optimal levels of design variables, their relationships with the responses and understanding the interaction among them is essential to form good joints. Design of experiment and evolutionary algorithms could be used to develop a mathematical relationship between the welding parameters and quality characteristics of the joint. The available literature had revealed a considerable interest in the application of response surface methodology (RSM) and artificial neural network to predict the responses. Optimization could be performed by using simulated annealing, genetic algorithm and particle swarm techniques. Among the three methods, genetic algorithm was observed to outperform the other methods [18]. Genetic algorithm was a good tool for experimental welding optimization even without a model for the process, however, difficulty was experienced in setting its parameters such as population size and number of generations for sufficient sweeping of search space. The technique of RSM technique was found to arrive at a better compromise between the evaluated responses though it struggles in the irregular experimental region [19]. The RSM technique was applied to find the optimal condition of friction welding parameters for joining dissimilar metals D3 tool steel and 304 austenitic stainless steel. The experimentation was based on Box–Behnken design to obtain the highest tensile strength [20]. The process parameters of friction welding were optimized using RSM for joining duplex stainless steel (DSS) UNS S32205. The central composite design (CCD) was used for experimentation. The upset pressure, friction pressure and speed of rotation were identified as most influencing parameters in maximizing the hardness and tensile strength [21, 22].

The application of hybrid techniques was employed for the optimization of process parameters and modeling the response values of various process. These integrated approaches have opened up the possibilities of combining the merits of the algorithms. The gray relational analysis was coupled with RSM technique for optimization and modeling of responses [22, 23]. The gray Taguchi-RSM was used for optimizing the friction welding parameters to join Al6061/SiC/Al_2O_3 metal matrix Composite [24]. It is a statistical tool used for optimization, and the technique is used to generate response surfaces to study the interaction effects of various design variables. Generally, Box–Behnken design and central composite design are used as the major response surface designs [23, 25, 26]. In a traditional RSM generating a quadratic response surface model for each of the responses, central composite design (CCD) or Box–Behnken design (BBD) is used for experimentation. This limits the study to the effects of design variables on single responses hence restricting the observations concerned with simultaneous optimization [27].

A considerable amount of literature is available in friction welding of similar and dissimilar materials of equivalent grade materials. An equivalent grade material, nuclear grade austenitic stainless steel 321 was joined by using a conventional TIG welding process, and their parameters were optimized using gray relational analysis to improve the mechanical properties of weld joints [28]. The effect of the heat input on the bead width and depth of penetration with various arc lengths was analyzed. The tensile strength measured at weld line (624 MPa) was observed higher than that of base metal (621 MPa). The flux activated—TIG welding process was employed for joining a square-groove butt weld joint of modified 9Cr–1Mo steel and the influence of MnO_2 flux activation on mechanical and metallurgical properties was analyzed. The activated TIG welding improved the depth of penetration and depth-to-width ratio (D/W) compared to the TIG welding process [29]. The Fe–2.25Cr–1Mo steel tube was joined with carbon steel tube using TIG welding process with the application of chromium containing filler material. The formation of Cr_2O_3 due to chromium content improved the corrosion resistance behavior of the weld [30]. The literature related to solid-state joining of EN 10028-P355 GH steel are not enough even the material has major applications in heat exchanger tubes. Further, little attention is observed in welding parameter design involving EN 10028-P355 GH steel within the scientific literature. Hence, the work explores the possibility of forming good quality welded joints using continuous drive friction welding with the objective of offering the guidelines and welding database for joining EN 10028-P355 GH steel using friction welding process. Though applications of RSM with central composite design are available in manufacturing processes, orthogonal arrays-based RSM is limited in the literature. Hence, the scope for simultaneous optimization of multiple responses is widened in the proposed work by application of an integrated approach of gray incidence reinforced response surface methodology for optimal parameter design.

2 Material and Experimental Procedure

2.1 Machine and Material

The EN 10028-P355 GH steel used as heat exchanger tubes is procured in the form of a normalized steel rod of diameter 16 mm. The chemical composition of parent material is as follows: Mn-1.10%, C-0.18%, Si-0.50%, Cr-0.30%, Mo-0.08%, Ni-0.5%, V-0.10, Cu-0.30%, S-0.01% and Fe-remaining. The rods machined to lengths of 130 mm each are subjected to friction welding in a continuous drive friction welding machine (Model: FW-6T) manufactured by RV machine tools, Coimbatore, India. The machine houses a hydraulic chuck with a spindle driven at a maximum speed of 3000 rpm and rated at 12 kW. The servomotor gearbox is used for slide drive, and the friction welding parameters are precisely set by 'Indra Control VCP-02' at the operator terminal. The machine has an inbuilt unit of the 'Rexroth controller' manufactured by the automation assembly unit of Bosch Rexroth, Germany (Fig. 1a, b).

(a) (b)

Figure 1 **a** Friction welding machine, **b** operator terminal

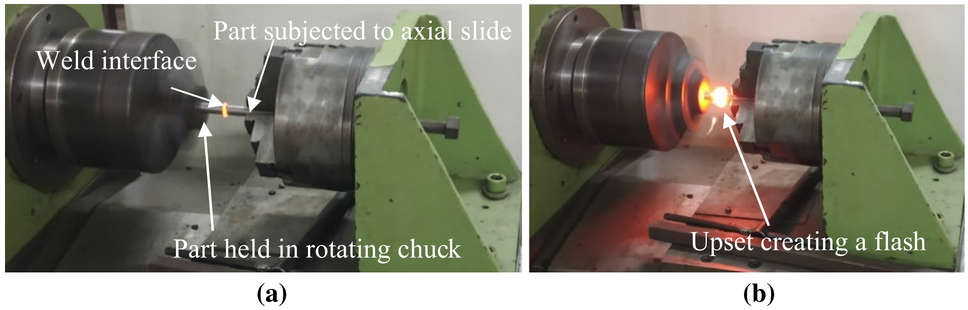

Figure 2 **a** Application of frictional pressure in the initial phase, **b** upset and formation of flash.

Table 1 Levels of various friction welding inputs

Friction welding inputs	Symbol	Unit	Levels of parameters		
			Level 1	Level 2	Level 3
Frictional pressure	A	MPa	70	90	110
Upset pressure	B	MPa	100	120	140
Frictional time	C	s	3	5	7
Forging time	D	s	3	5	7
Rotational speed	E	rpm	1000	1200	1400

Fig. 3 Sample joints formed during friction welding

2.2 Experimentation

During friction welding, one half of the joint was attached to spindle drive, precisely controlled by Rexroth while the other half is held stationary and impending to slide. The two parts are allowed to get in contact after ensuring equal overhang on both the parts to be joined. With the required setting of parameters, a smooth transition is ensured across different phases of the formation of joint. Figure 2a, b shows the initial phase, upset and formation of flash at weld interface during the process of friction welding. The predominant welding parameters used in experimentation include the frictional pressure, friction time, upset pressure, forging time and rotational speed [20, 21]. These parameters affect the temperature, and hence, the plastic flow at weld interfaces determining the joint characteristics [4, 6, 8, 16, 22]. The levels of various parameters were found out using the preliminary experimental trials resulting in bonds without any defects/failure on visual inspection. Trials for determining the range of various parameters were conducted based on pre guidance from scientific literature. Table 1 displays the levels of various welding parameters used in experimentation.

Taguchi's orthogonal array (L_{27}) was used to conduct the experiments, which opens the possibility of studying the necessary interaction effects among various design variables [27]. The quality characteristics include the yield strength (YS), ultimate tensile strength (UTS), axial shortening (AS) and impact toughness (IT). To reduce the effects of uncontrollable factors, the trials were conducted at random [20] with necessary replications, and the formed joints were observed for the quality characteristics. The sample joints formed during experimentation are shown in Fig. 3.

The tension test was performed in Instron-Computerized tension tester after preparing the specimen as per the ASTM E8 standard. The layout of specimen for tensile testing is shown in Fig. 4. A few samples of tensile specimen before and after testing are shown in Fig. 5. Failure was observed near the weld interface in most of the samples subjected to tension tests.

Axial shortening was measured as the decrease in length of the final joint obtained at the end of the friction welding process. Impact toughness was primarily studied to observe the effect of larger deformation speeds on the material. The amount of energy absorbed by the specimen during fracture, as observed from the impact test gives a toughness measure of samples. This offers the scope for further studies related to the ductile–brittle transition. Charpy V-notch testing (pendulum type) is performed to find the energy absorbed by samples on dynamic loading as per ASTM E23 standard. The layout of specimen for impact testing is shown in Fig. 6. The sample specimen for the Charpy V-notch test after failure is shown in Fig. 7. The quality characteristics observed in various friction

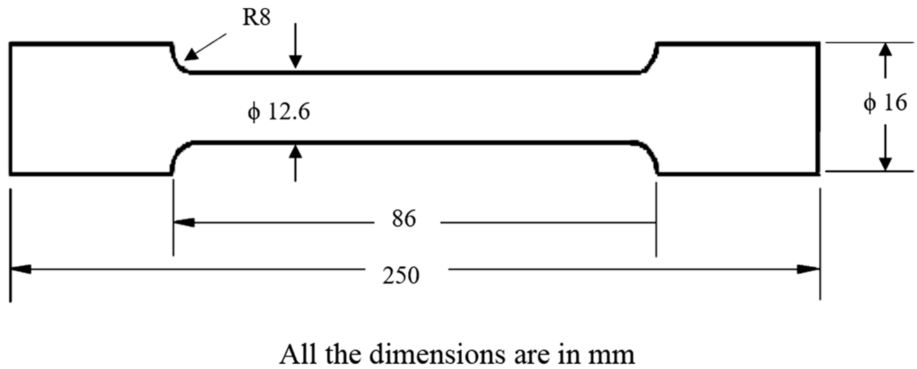

Fig. 4 Layout of specimen for tensile testing

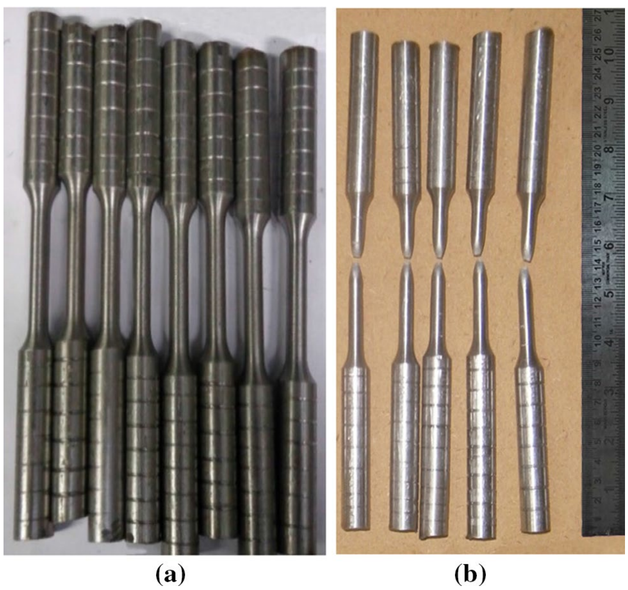

Fig. 5 Samples **a** before tension test, **b** after tension test

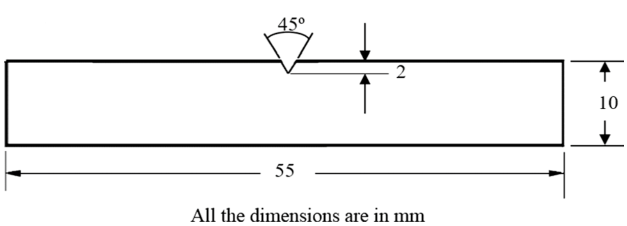

Fig. 6 Layout of specimen for Charpy V-notch test

Fig. 7 Specimen subjected to Charpy V-notch test

welded joints formed using different combinations of welding inputs (L_{27} orthogonal array) is shown in Table 2.

3 gray Incidence Reinforced Response Surface Methodology

RSM is a statistical approach with a module for modeling the design variables and desirability analysis for optimizing the responses. The effects of parameters on responses are illustrated by 3D surface graphs. The integrated strategy of gray incidence reinforced response surface methodology combines the uncertainty handling ability of gray incidence analysis with the modeling abilities of RSM. The multiple responses observed via experimentations are transformed into a single measure of quality as gray relational grade (GRG). It is used for further modeling using RSM and simultaneous optimization of the welding inputs (design variables). The various steps in gray incidence reinforced response surface methodology are presented in two stages.

3.1 Part I: gray Incidence Analysis

During the first stage of gray incidence, the experimental data are processed by calculating the reciprocal of coefficient of variation termed as the 'signal-to-noise' (S/N) ratio. The normalized S/N ratio converts experimental data in the range of zero to one. The processed data are further analyzed by forming gray relational grade and projecting it as the single representative of various outputs obtained from experimentations. The various steps are discussed below.

Step 1 Estimate the S/N ratio (η_{ij}) for each output using the appropriate equation based on its quality characteristics. The three formats in which an output are analyzed include the following: *nominal-the-best, smaller-the-better or larger-the-better*. A *nominal-the-best* characteristic has a user-defined target value. The target of *smaller-the-better* characteristic is attaining a minimum value of response (zero), while a *larger-the-better* characteristic has a target of infinity i.e. attaining a

Table 2 Levels of various friction welding inputs and observed responses

Trial order	Friction welding inputs						Responses							
Actual	Random	*A*	*B*	*C*	*D*	*E*	YS (MPa)		UTS (MPa)		AS (mm)		IT (J)	
1	7	70	100	3	3	1000	281.95	282.55	483.02	485.10	10.50	10.67	14	15
2	23	70	100	5	5	1200	304.35	304.75	501.60	503.60	16.80	16.63	18	18
3	3	70	100	7	7	1400	314.46	314.06	551.55	553.55	21.10	22.93	21	20
4	4	70	120	3	5	1400	286.54	287.14	525.70	525.70	15.80	15.97	17	17
5	17	70	120	5	7	1000	276.13	275.73	548.55	548.55	22.70	22.70	18	16
6	22	70	120	7	3	1200	290.82	291.54	563.35	562.35	16.20	16.37	19	19
7	2	70	140	3	7	1200	305.39	305.79	592.80	593.80	22.20	22.37	19	18
8	8	70	140	5	3	1400	300.24	300.24	542.80	540.80	20.90	21.07	21	22
9	12	70	140	7	5	1000	310.48	310.88	578.05	576.05	24.80	24.80	20	20
10	14	90	100	3	3	1000	308.25	307.85	584.25	585.25	12.60	12.27	17	18
11	27	90	100	5	5	1200	316.24	316.24	587.10	588.10	17.80	17.80	19	20
12	9	90	100	7	7	1400	320.15	319.55	599.45	600.45	23.60	23.77	22	21
13	25	90	120	3	5	1400	319.51	319.11	581.68	582.95	20.90	20.90	20	20
14	26	90	120	5	7	1000	320.27	320.67	575.70	576.70	21.40	21.07	19	18
15	13	90	120	7	3	1200	313.54	313.74	586.15	589.15	22.40	22.23	20	20
16	16	90	140	3	7	1200	317.87	317.47	584.25	586.25	23.20	23.20	21	22
17	20	90	140	5	3	1400	319.26	319.26	570.10	570.10	20.40	20.40	22	22
18	15	90	140	7	5	1000	319.77	319.97	548.55	547.55	22.10	22.77	20	21
19	5	110	100	3	3	1000	304.14	303.94	549.10	551.10	15.70	15.37	17	17
20	10	110	100	5	5	1200	319.27	319.87	581.40	582.40	21.90	21.23	18	20
21	18	110	100	7	7	1400	330.65	330.85	602.15	601.23	24.60	25.37	21	18
22	6	110	120	3	5	1400	321.54	321.14	600.40	598.40	22.80	22.37	19	18
23	1	110	120	5	7	1000	308.47	309.07	557.55	559.55	21.60	21.27	17	17
24	11	110	120	7	3	1200	319.67	319.67	606.10	605.10	22.70	22.03	18	18
25	24	110	140	3	7	1200	309.82	309.82	593.95	596.95	20.90	21.07	20	18
26	21	110	140	5	3	1400	312.52	311.92	605.15	606.15	25.70	25.87	22	20
27	19	110	140	7	5	1000	310.84	310.44	578.40	579.40	24.20	24.37	20	22

maximum value of output. The S/N ratio (η_{ij}) for such characteristics is calculated by using Eqs. (1) and (2).

$$\text{Smaller-the-better characteristic:}\quad \text{S/N Ratio}(\eta) = -10\log_{10}\left(\frac{1}{r}\cdot\sum_{i=1}^{r} y_{ij}^2\right) \tag{1}$$

$$\text{Larger-the-bettercharacteristic}:\quad \text{S/N Ratio}(\eta) = -10\log_{10}\left(\frac{1}{r}\right)\sum_{i=1}^{r}\frac{1}{y_{ij}^2} \tag{2}$$

where y_{ij} = observed response values, $i = 1, 2, 3 \ldots r$, and $j = 1, 2, \ldots m$, r = number of replications, m = number of observations.

Step 2 Estimate the normalized S/N ratio (Z_{ij}) using Eq. (3) to reduce the variability among the calculated values of S/N ratio for various responses. 'n' represents the number of trials.

$$Z_{ij} = \frac{y_{ij} - \min(y_{ij}, i = 1, 2, \ldots, n)}{\max(y_{ij}, i = 1, 2, \ldots, n) - \min(y_{ij}, i = 1, 2, \ldots, n)} \tag{3}$$

Step 3 calculate the gray incidence coefficient (γ) from the normalized S/N ratio values using Eq. (4)

$$\gamma_i^j = \frac{\Delta \min + \xi \Delta \max}{\Delta_{oj}(i) + \xi \Delta \max} \tag{4}$$

where $i=1, 2\ldots.n$ and $j=1,2\ldots.m$, n is the number of responses and m is the number of trials.

$\Delta_{oj} = \left\| z_o(i) - z_j(i) \right\|$, $z_o(i)$ is the reference sequence ($z_o(i)=1$; $i=1,2,\ldots,n$) and $z_j(i)$ is the specific comparison sequence.

$\Delta \min = \min\limits_{\forall j \in i} \min\limits_{\forall i} \left\| z_o(i) - z_j(i) \right\|$ is the smallest value of $z_j(i)$, $\Delta \max = \max\limits_{\forall j \in i} \max\limits_{\forall i} \left\| z_o(i) - z_j(i) \right\|$ is the largest value of $z_j(i)$, and 'ξ' is the distinguishing coefficient whose value is taken as 0.25.

Step 4 Find the GRG values (γ_i) for every trial using Eq. (5)

$$\mathrm{GRG}_i = \frac{1}{n}\sum_{i=1}^{n}(\gamma_i). \tag{5}$$

3.2 Part II: GRG Reinforced RSM

The GRG value for various trials is seen as a single quality measure representing various responses. The GRG value for various experimental conditions is used in the RSM technique as a single response and a polynomial model for GRG value is generated. The response surfaces plots are also generated to observe the influence of welding inputs.

Step 5 Execute the analysis of variance (ANOVA) using GRG values to find the significant contribution of welding inputs.

Step 6 Develop a quadratic model to relate the GRG with various inputs and their interactions. Test the model fitness with the experimental data.

Step 7 Plot the response surfaces (3D) graphs to study the effects of various welding inputs on GRG and use desirability analysis to find the optimal welding condition. Validate the same via experimentations.

4 Results and Discussion

4.1 gray Incidence Analysis and GRG Values

gray incidence analysis was performed using the gray theory which uses S/N ratio as the preliminary index and gives solutions that are more appropriate to real-world problems [20]. The three quality characteristics studied via experimentations (YS, UTS and IT) were treated as 'larger-the-better' characteristics with an intended magnitude of one, while the fourth response (AS) was analyzed as the 'smaller-the-better' characteristic with a desired value of zero. The calculated S/N values of various responses were subjected to linear normalization to align those towards normal distribution and make the values of design variables more comparable. The normalized values of S/N ratios are presented in Table 3. The GRG values were obtained using the GRC values calculated using Eq. (6). The GRG functions as a representative for the various measured responses, deserving a higher value regardless of their nature. The variations in GRG values for the 27 experimental trials are described graphically in Fig. 8. The maximum observed value of GRG was 0.6370 (21^{st} trial), indicating a closer proximity of the experimental conditions to a near-optimal one.

4.2 Second-Order Polynomial for GRG (Fitness and Adequacy)

The methodology of RSM uses a mathematical technique for model building. The design variables used in friction welding were mapped with the quality characteristics observed in solid-state joints in terms of GRG. A quadratic model [Eqs. (6), (7)] which was a polynomial of order two was formed to relate the various welding inputs with GRG using Design-Expert software. The formulated model includes both individual and interaction effects of various welding inputs on GRG thus offering the scope to observe the mathematical behavior within the system. Equations (6, 7) represent the representative of responses (GRG) in terms of coded and actual factors respectively. The insignificant terms were excluded (model reduction) to make it less expensive computationally, but preserving the closeness and stability of actual model [20]. A considerable reduction in the number of experimental trials was realized with the L_{27} orthogonal array compared to the conventional experimental designs (CCD/BBD) used with RSM [27].

$$\begin{aligned}\mathrm{GRG} = {} & +0.50 + 0.054 \times A + 0.057 \times B + 0.064 \\ & \times C - 0.043 \times D + 0.052 \times E + 0.020 \\ & \times A \times C + 0.045 \times A \times E - 0.082 \times B \times C \\ & + 0.080 \times B \times D + 0.091 \times C \times D - 0.076 \times A^2\end{aligned}$$

$$\begin{aligned}\mathrm{GRG} = {} & +0.014862 + 0.020672 \times A + 3.03400 \times 10^{-3} \\ & \times B + 0.11713 \times C - 0.37594 \times D - 7.58611 \times 10^{-4} \\ & \times E + 5.01554 \times 10^{-4} \times A \times C + 1.13312 \times 10^{-5} \\ & \times A \times E - 2.04031 \times 10^{-3} \times B \times C + 2.00232 \times 10^{-3} \\ & \times B \times D + 0.022870 \times C \times D - 1.89203 \times 10^{-4} \times A^2\end{aligned}$$

Analysis of variance (Table 4) was carried out to study the model adequacy and fitness in relating the welding inputs with GRG [23, 24]. This could help in understanding the importance of model coefficients identified using Design−Expert software in forming a technical link with responses represented by GRG. The polynomial model was found to be significant with an F value of 14.97 and a p value of less than 0.0001, declaring the minimal effects of noise factors. The p value probability less than 0.05 indicates the substantial importance of all the terms in the model including frictional pressure (A), upset pressure (B), friction time

Table 3 Calculations leading to the performance index

Trial	S/N ratio				Normalized S/N ratio				gray relational co-efficient (GRC)				GRG
	YS	UTS	AS	IT	YS	UTS	AS	IT	YS	UTS	AS	IT	
1	49.013	53.697	– 20.493	23.212	0.125	0.000	1.000	0.000	0.222	0.200	1.000	0.200	0.4055
2	49.673	54.024	– 24.463	25.105	0.545	0.168	0.487	0.521	0.354	0.231	0.327	0.343	0.3139
3	49.946	54.847	– 26.863	26.227	0.718	0.591	0.176	0.829	0.470	0.379	0.233	0.594	0.4189
4	49.153	54.415	– 24.019	24.609	0.214	0.369	0.544	0.384	0.241	0.284	0.354	0.289	0.2919
5	48.816	54.784	– 27.121	24.564	0.000	0.558	0.143	0.372	0.200	0.361	0.226	0.285	0.2679
6	49.283	55.008	– 24.235	25.575	0.297	0.673	0.516	0.650	0.262	0.433	0.341	0.417	0.3632
7	49.703	55.465	– 26.960	25.334	0.563	0.908	0.164	0.584	0.364	0.731	0.230	0.375	0.4251
8	49.549	54.677	– 26.438	26.642	0.466	0.503	0.231	0.943	0.319	0.335	0.245	0.815	0.4284
9	49.846	55.224	– 27.889	26.021	0.655	0.784	0.044	0.772	0.420	0.537	0.207	0.523	0.4218
10	49.772	55.339	– 21.893	24.850	0.608	0.843	0.819	0.450	0.389	0.615	0.580	0.313	0.4741
11	50.000	55.382	– 25.008	25.792	0.752	0.865	0.416	0.710	0.502	0.649	0.300	0.463	0.4785
12	50.099	55.562	– 27.489	26.642	0.815	0.958	0.095	0.943	0.575	0.856	0.217	0.815	0.6154
13	50.084	55.303	– 26.403	26.021	0.806	0.825	0.236	0.772	0.563	0.588	0.247	0.523	0.4801
14	50.116	55.211	– 26.541	25.334	0.826	0.778	0.218	0.584	0.589	0.529	0.242	0.375	0.4339
15	49.929	55.382	– 26.973	26.021	0.707	0.865	0.162	0.772	0.460	0.650	0.230	0.523	0.4658
16	50.040	55.347	– 27.310	26.642	0.777	0.847	0.119	0.943	0.529	0.621	0.221	0.815	0.5463
17	50.083	55.119	– 26.193	26.848	0.805	0.730	0.263	1.000	0.562	0.481	0.253	1.000	0.5739
18	50.099	54.776	– 27.019	26.227	0.815	0.554	0.156	0.829	0.575	0.359	0.229	0.594	0.4393
19	49.659	54.809	– 23.826	24.609	0.535	0.571	0.569	0.384	0.350	0.368	0.367	0.289	0.3434
20	50.091	55.297	– 26.677	25.539	0.810	0.822	0.200	0.640	0.568	0.584	0.238	0.410	0.4501
21	50.390	55.587	– 27.954	25.724	1.000	0.971	0.035	0.691	1.000	0.895	0.206	0.447	0.6370
22	50.139	55.554	– 27.076	25.334	0.841	0.954	0.149	0.584	0.611	0.844	0.227	0.375	0.5141
23	49.793	54.941	– 26.622	24.609	0.621	0.639	0.207	0.384	0.397	0.409	0.240	0.289	0.3337
24	50.094	55.644	– 26.993	25.105	0.812	1.000	0.160	0.521	0.571	0.999	0.229	0.343	0.5353
25	49.822	55.497	– 26.438	25.539	0.639	0.924	0.231	0.640	0.409	0.767	0.245	0.410	0.4579
26	49.889	55.644	– 28.227	26.415	0.682	1.000	0.000	0.881	0.440	1.000	0.200	0.677	0.5792
27	49.845	55.252	– 27.706	26.415	0.654	0.799	0.067	0.881	0.419	0.554	0.211	0.677	0.4653

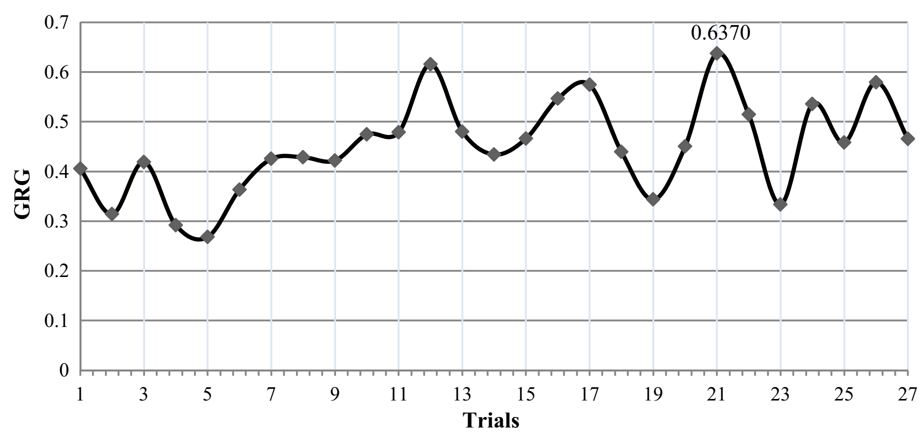

Fig. 8 Plot of GRG values for different experimental trials

(C), forging time (D), rotational speed (E) and their interactions (AE, BC, BD and CD). Second-order of term A (frictional pressure) was also found to be significant in influencing the GRG and hence the responses. The quadratic model was capable of simulating the solid-state friction welding conditions in EN 10028-P355 steel.

The *R*-squared value (coefficient of determination) and adequate precision value is shown in Table 5. The *R*-squared value is a statistical measure to understand the closeness

Table 4 ANOVA for response surface quadratic model

Source	Sum of squares	Degrees of freedom	Mean sum of square	*F* value	*p* value	Remarks
Model	0.212782	11	0.019344	14.97374	< 0.0001	Significant
A—Frictional pressure	0.053276	1	0.053276	41.23997	< 0.0001	
B—Upset pressure	0.025479	1	0.025479	19.723	0.0005	
C—Friction time	0.020368	1	0.020368	15.76649	0.0012	
D—Forging time	0.009158	1	0.009158	7.089374	0.0177	
E—Rotational speed	0.007017	1	0.007017	5.431853	0.0341	
AC	0.00483	1	0.00483	3.73874	0.0723	
AE	0.024652	1	0.024652	19.08267	0.0006	
BC	0.011656	1	0.011656	9.0228	0.0089	
BD	0.011226	1	0.011226	8.689914	0.0100	
CD	0.029291	1	0.029291	22.67372	0.0003	
A^2	0.034366	1	0.034366	26.60214	0.0001	
Residual	0.019378	15	0.001292			
Cor total	0.232159	26				

Table 5 Coefficient of determination and model discrimination

SD	0.036	*R*-squared	0.9378
Mean	0.45	Adj *R*-squared	0.8553
C.V. %	7.98	Pred *R*-squared	0.7114
PRESS	0.067	Adeq precision	14.205

of data to the regression line. A higher value of the coefficient of determination (greater than 0.7) is desired to ensure better fitness of the generated model to experimental data. The *R*-squared value of 0.9378, nearer to unity ensures a good fit between the generated polynomial equation and data measured within the welding domain. Though the predicted *R*-squared value (0.7114) was observed to be lesser than the adjusted *R*-squared value (0.8553), it proves the capability of the model to predict the response for a new set of observations in welding inputs. The predicted *R*-squared value (0.7114) observed from Table 5 was reasonable in preventing an overfit model, which would explain noise otherwise. Adequate precision could compare the range of predictions from the polynomial model to the associated errors. Adequate Precision was observed to be 14.205 (a value greater than 4 is desired), which proves the sufficiency in model discrimination in terms of signal adequacy. Hence the generated polynomial equation can be deemed fit and adequate in describing the relationship between the welding inputs and response represented in terms of GRG.

The closeness of actual and predicted values of response (GRG) for the 27 trials is shown in Fig. 9 (Plot of the predicted versus actual GRG values). The points are closer to the diagonal regression line without a foggy pattern proving the model fitness [24]. The plot of internally studentized

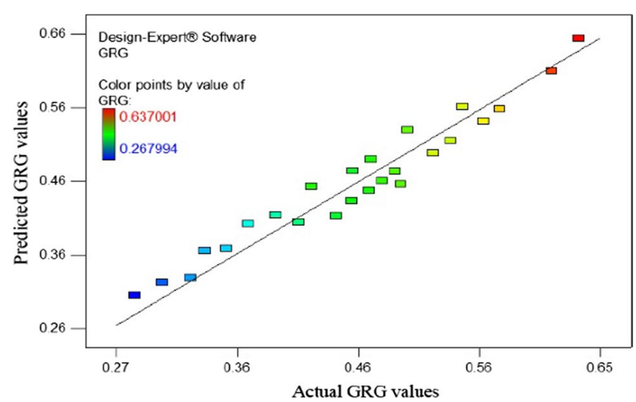

Fig. 9 Scatter plot of predicted versus actual GRG values

residuals is shown in Fig. 10. It considers the difference in predicted and observed values of GRG along with the standard deviation. The majority of the residuals are observed to be positive or along the diagonal line with an almost symmetric distribution without any clear patterns. The randomness in the residual plot further ascertains the fitness of the generated model for the response.

4.3 Analysis of Response Surface Plots

The various welding parameters including the frictional pressure, friction time, upset pressure, forging time and rotational speed, along with their interactions were observed to influence the yield strength, tensile strength, impact toughness and axial shortening significantly. Frictional pressure along with a defined rotational speed helps in creating the required temperature at the weld interface. The heat generation at the

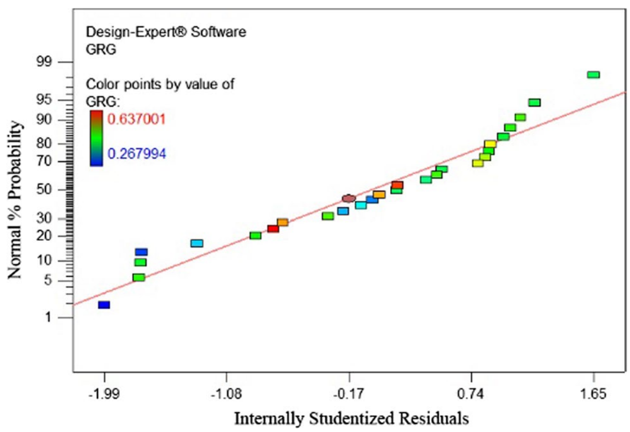

Fig. 10 Plot of studentized residuals to ascertain fitness

localized region is due to the rubbing action of irregularities in the mating surface. The constant frictional pressure ensures flattening of irregularities at the weld interface eliminating surface preparation in friction welding. A moderate value of frictional pressure (93 MPa) was observed to produce a better response as observed from the response surface plots (Fig. 11a, b). However, a moderate level of friction time (5.22 s) was desired to generate the heat and necessary temperature at the interface (Fig. 11b–d). A higher value of upset pressure (138 MPa) was found to produce a larger GRG (Fig. 11c, e) and hence, an improved response. The effect of upset along with the frictional energy input softens the materials assuring a plastic flow at the interface in the form of flash creating a good bond. When the forging pressure was maintained for more time, a considerable axial shortening was observed, and GRG was observed to decrease. Increased forging time allows for more heat dissipation in lesser time by increasing the surface area of flash. This could cause an increased hardness at the weld interface area. Hence, a small forging time was desired as observed from the plots (Fig. 11d, e). Also heat transfer by forced convective mode was realized at higher rotational speeds resulting in temperature drop at an increased rate. Hence, a moderate value of rotational speed (1282 rpm) was observed to be effective in producing better response (Fig. 11a).

4.4 Desirability Analysis on GRG Values and Ramp Graph

The technique of desirability analysis uses a desirability function to identify the scale-free value of desirability for the various responses [27]. The desirability function used in analysis of the calculated GRG values is of 'larger-the-better' type which forms the individual values of desirability ranging from zero to one. The combination of friction welding inputs producing the maximum value of desirability was identified and marked as the near-optimal condition (frictional pressure-93.94 MPa, friction time-5.22 s, upset pressure-138.14 MPa, forging time-3.58 s and rotational speed-1282.67 rpm). The outcome of desirability analysis is presented in Table 6. The ramp graph with optimal levels of welding inputs is shown in Fig. 12. The ramp graphs of individual welding inputs are combined and presented for the greatest overall desirability. The red dot on each ramp shows the most desired level of each welding input within the range chosen for experimental trials, hence representing the highest value of GRG (0.6508).

4.5 Welding Trial Using Predicted Optimal Values of Inputs

A proper experimental endorsement of near-optimal setting of friction welding inputs (frictional pressure-93.94 MPa, friction time-5.22 s, upset pressure-138.14 MPa, forging time-3.58 s and rotational speed-1282.67 rpm) becomes important to validate the approach of gray incidence reinforced response surface methodology and confirm the improvement in the observed quality characteristics. The outputs of experimental trial (No. 21) with the largest calculated value of GRG (0.6370) were compared with outputs obtained with the optimal setting of welding inputs predicted by gray incidence reinforced response surface methodology. Improvements were observed in the quality characteristics of the joint formed with optimal welding inputs substantiating the approach adopted for multi-response optimization. The properties of joint obtained with optimal parameters are YS = 339.42 MPa, UTS = 612.21 MPa and IT = 27 J, and properties of base metal are YS = 292 MPa, UTS = 528 MPa, IT = 23.90 J. It was observed that the YS and UTS are appeared higher than the values observed at base metal. The improvement in impact toughness appears minimal, but still the value (23.90 J) appears closer to the impact toughness value of parent material (27 J), during Charpy V-notch testing. The axial shortening obtained with the optimal setting of welding inputs was not significantly remarkable (20.75 mm). However, tensile strength and impact toughness were observed to be good at moderate/higher values of axial shortening. Hence, a good bond which promises good mechanical properties can be obtained with only reasonable values of shortening (Table 7).

4.6 Macroscopic and Microscopic Examination of Optimal Joint

The joint formed with an optimal welding input setting is shown in Fig. 13a, b. The heat flux generated due to frictional pressure and rotational speed creates the necessary thermal input for the softening of material closer to the weld interface. The application of optimal upset pressure creates

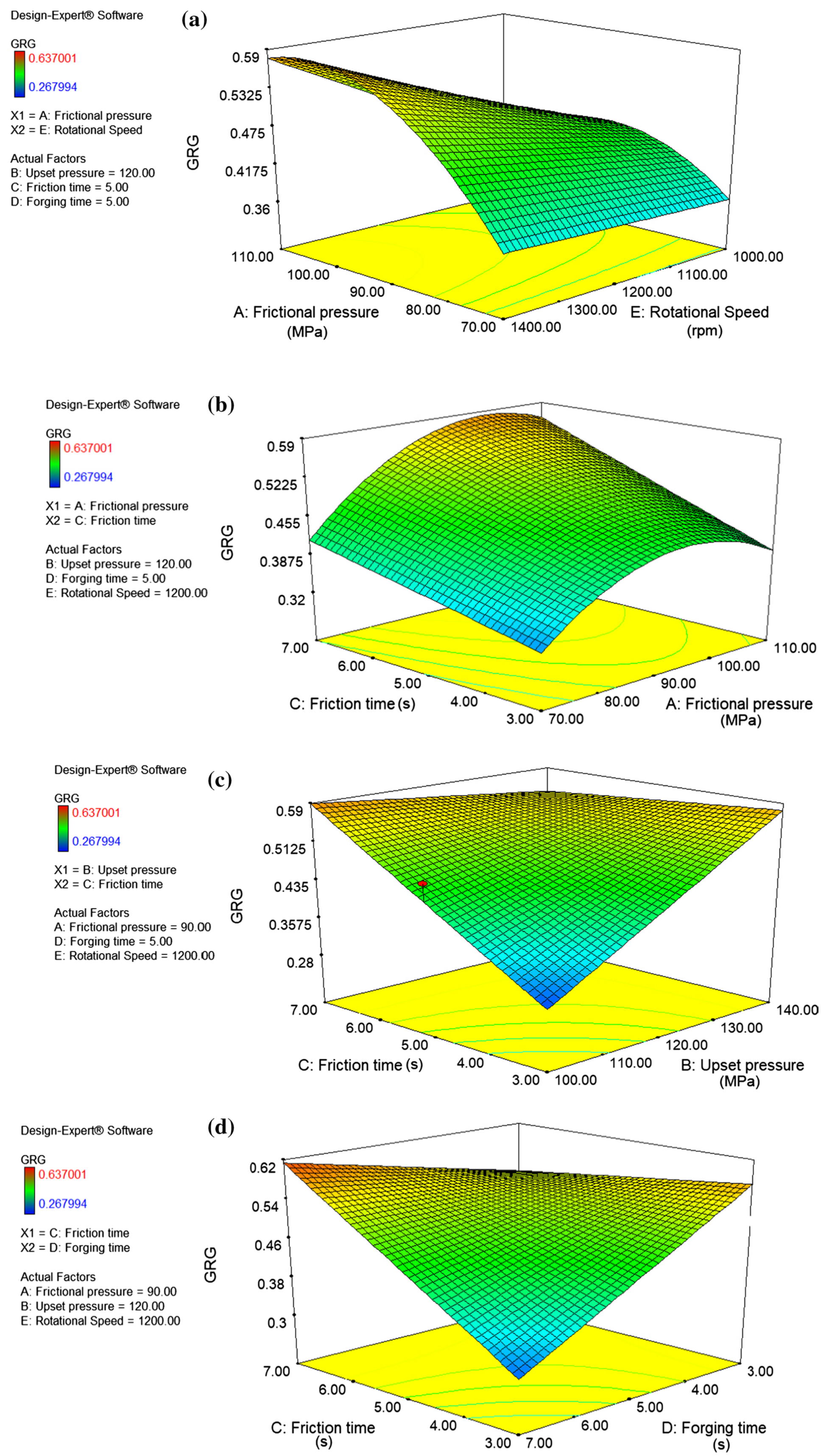

Fig. 11 Response surface plots displaying the parameter effects on GRG, **a** frictional pressure and rotational speed, **b** friction time and frictional pressure, **c** friction time and upset pressure, **d** forging time and friction time, **e** upset pressure and forging time

Fig. 11 (continued)

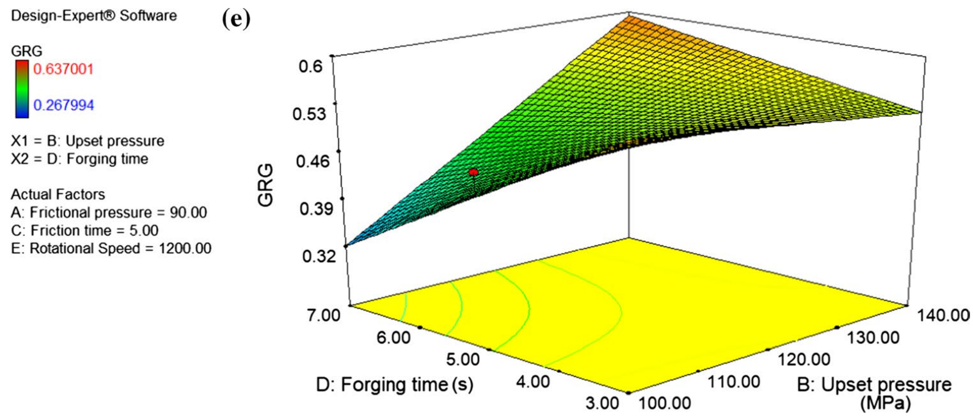

Table 6 Optimal levels of friction welding inputs

Symbol	Welding inputs	Optimal level	Low level	High level
A	Frictional pressure	93.944	70	110
B	Upset pressure	138.147	100	140
C	Frictional time	5.22	3	7
D	Forging time	3.58	3	7
E	Rotational speed	1282.67	1000	1400
Response	Prediction	SE mean	95% CI low	95% CI high
GRG	0.65088	0.06041	0.520419	0.780006

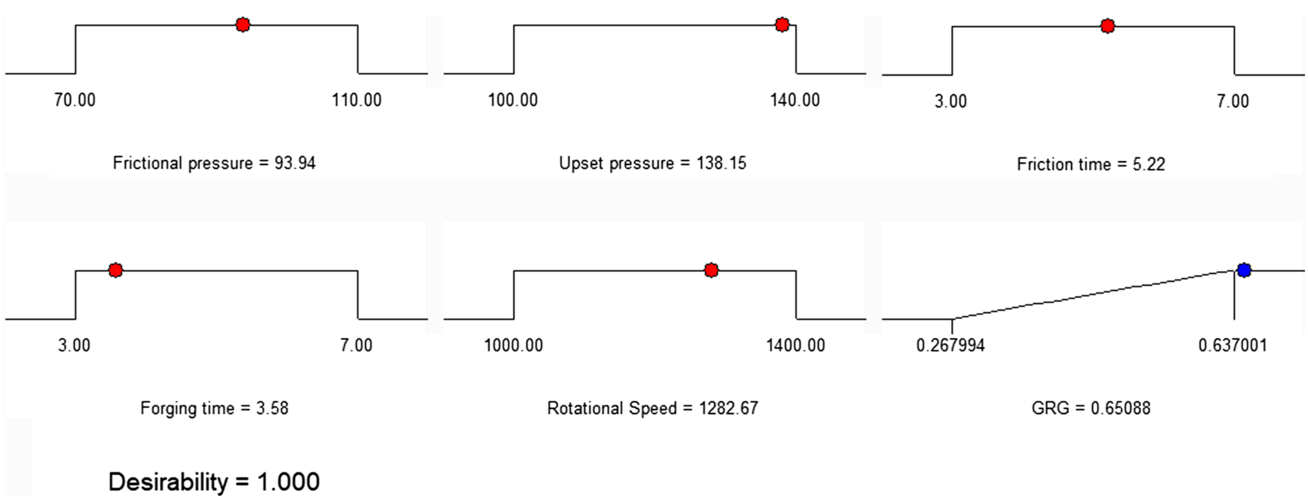

Fig. 12 Ramp graph with optimal level of friction welding inputs

Table 7 Responses obtained with optimal friction welding inputs

Responses	Initial setting	Optimal setting	Enhancement
GRG	0.637	0.65088	0.01388
Yield strength (MPa)	330.62	339.42	8.80
Ultimate tensile strength (MPa)	600.54	612.21	11.67
Axial shortening (mm)	24.15	20.75	3.40
Impact toughness (J)	21.70	23.90	2.20

plastic movement of material closer to interface radially outwards in the form of flash. The curl of parent material in the form of flash was evident, and the weld penetration was thoroughly complete as the weld line was not visible in Fig. 13b. Macroscopic examination further reveals the uniform width of flash, portraying the goodness of bond. The stereo microscope (model SZX16) equipped with DP series digital camera, and an inbuilt imaging software was used to analyse the microstructural characteristics near the weld area (Figs. 14, 15). The weld zone including the interface is seen along with the advancing and receding parts of the joint.

The microstructure of the tensile and impact specimen formed from the bonds with optimal parameter setting is shown in Fig. 14a, b. In both the microstructures, a small amount of pearlitic phase and predominantly ferritic phases are seen. However, pearlite itself is made of ferritic and cementite bonds [6, 8]. The grains appear to be pulled along the direction of uniaxial loading in tensile specimen (Fig. 14a), however, a relatively equi-axed grain is seen in impact specimen (Fig. 14b).

The region circled in Fig. 15a is enlarged to make a clear picture of the different zones near the weld area. Three different regions observed near the weld area

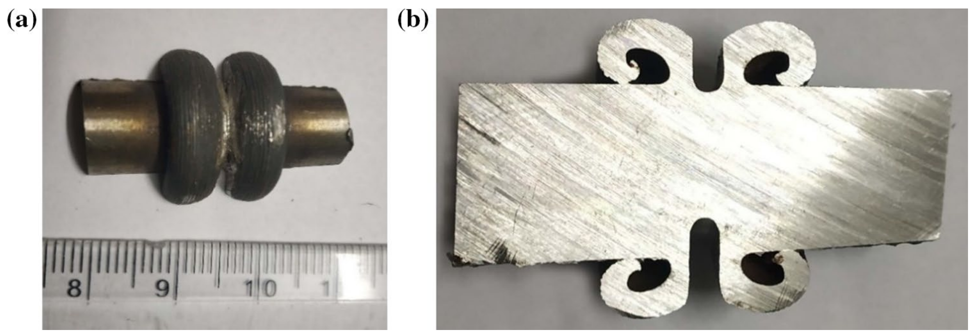

Fig. 13 **a** Weld interface of optimal joint, **b** longitudinal cut section revealing flash.

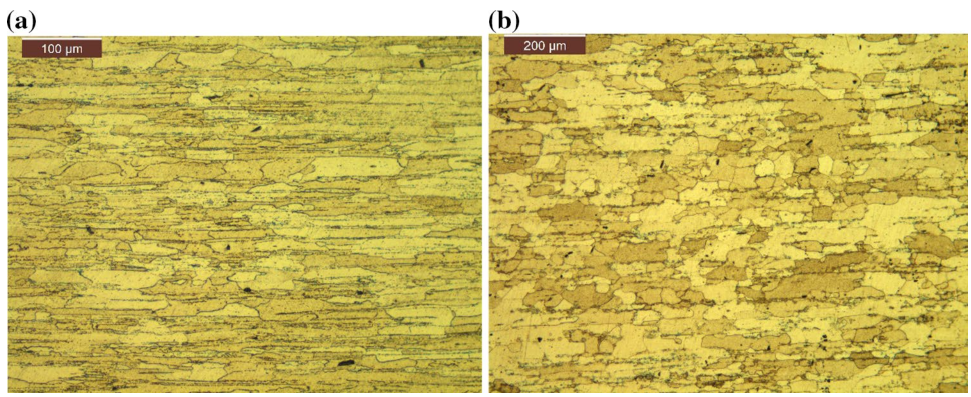

Fig. 14 Microstructure of **a** tensile specimen, **b** impact specimen

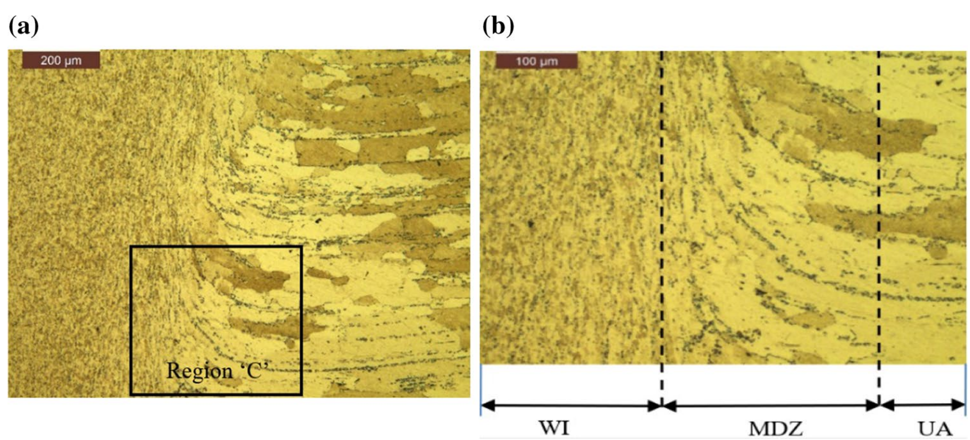

Figure 15 **a** Weld interface of optimal joint, **b** different areas near weld line

include the weld interface (WI), moderately deformed area (MDA) and the unaffected area (UA) (Fig. 15 b). The microstructures on the weld interface are characterized by the dynamic recrystallization due to higher rotational speed. The weld interface appears relatively darker compared to the other areas, as it was subjected to high temperature, stress and deformation. The grains appear dragged in the moderately deformed zone because of torque experienced by rotation at higher temperatures. More drag was found in the advancing part of the joint compared to the retreating half. The unaffected area signals the end of plastic flow and the onset of parent material away from the joint interface on both sides. Hence, the softening of material due to thermal input was more evident in the weld interface and moderately deformed zone. The remaining part of `parent material was unaffected by temperature and stress hence reducing the chances of undesirable microstructural changes and degradation of properties a possibility in fusion welded joints. The fractured surface of bond subjected to tensile loading is shown in the scanning electron microscope (SEM) images in Fig. 16a–c. Fracture was observed near the weld area as it happened in most of the experimental trials.

A gross permanent deformation (necked down) was observed near the center of the workpiece in Fig. 16a, and a closer examination reveals the microfractures and smaller voids, which appear after the specimen was stressed beyond tensile strength (Fig. 16b). The plastic deformation from the necked down area is also visible in Fig. 16c. These are primarily the features or patterns observed in ductile failure in uniaxial tension. The Vicker's hardness values were measured from the weld line towards unaffected parent material on both sides of the weld zone as per the ASTM E-18 standard with the total test force of 100 g for 10 s time. The hardness values measured at the WI, MDA and UA for the optimal joint were 204, 181 and 168 respectively. The joint obtained using initial input parameter setting (Trial No: 21) was found to possess a hardness value of WI, MDA and UA are 198, 178 and 166 respectively. Hence, it was observed that the hardness in the weld zone is relatively higher than that in the unaffected zone of parent material.

5 Conclusion

An effective attempt has been made to joint EN 10028-P355 GH steel in solid-state and possibility of forming good quality welded joints using continuous drive friction welding was also explored. The scope for simultaneous optimization of multiple responses is widened by authorizing an integrated approach of gray incidence reinforced response surface methodology for optimal parameter selection. A notorious reduction in the number of experiments was observed, as L_{27} orthogonal array was used in experimental trials unlike the

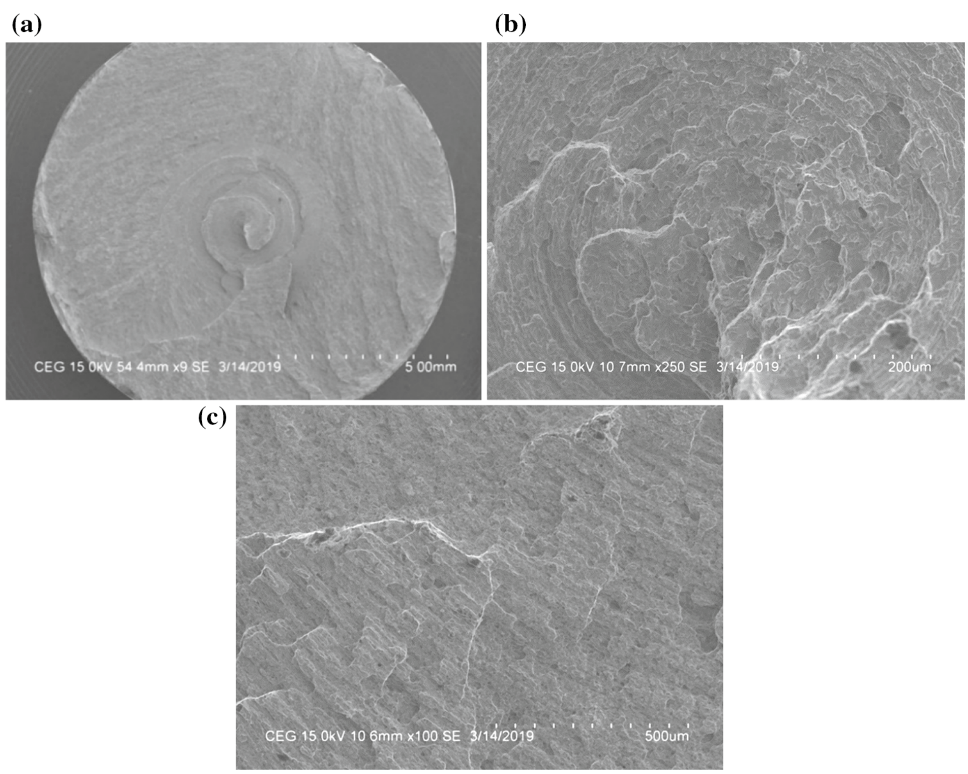

Figure 16 **a** Fractured surface, **b** voids and coalescence, **c** closer look at 'necked down' surface

conventional strategies using CCD or BBD with traditional RSM to arrive at the optimal friction welding inputs. The conclusions drawn include the following.

1. The gray incidence reinforced response surface methodology was effective in predicting the near-optimal welding condition (frictional pressure-93.94 MPa, friction time-5.22 s, upset pressure-138.14 MPa, forging time-3.58 s and rotational speed-1282.67 rpm) for joining EN 10028-P355 GH steel in a solid-state.
2. The developed quadratic model was adequate and effective in relating the various welding inputs and predicting the responses in terms of gray relational grade. The predicted and experimentally observed values were found to be reasonably closer demonstrating the model adequacy.
3. In addition to the individual welding parameters, their interactions were also observed to influence the quality characteristics of the joints. A ductile pattern was found in the fractured surface of joint.
4. The optimal welding inputs predicted by the integrated approach of gray incidence reinforced response surface methodology were found to improve the tensile strength and impact toughness. However, a less significant reduction in axial shortening could be better understood from the point of formation of a good bond with reasonably improved strength.

The findings of study could offer the sought-after guidelines for joining EN 10028-P355 GH steel in solid-state using continuous drive friction welding. The generated polynomial equations along with the experimentations will provide the necessary databank for improving the joining characteristics of material employed in boilers and pressure vessels, where the quality of joints is of utmost importance. The results could contribute in enhancing the engineering applications of the material and usage of gray incidence reinforced response surface methodology in different manufacturing strategies. The scope can be extended further to modeling the temperature at the weld interface, correlating the same with joint properties and studying the effects on ductile–brittle transition.

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Compliance with Ethical Standards

Conflict of interest The authors declare no possible conflict of interest regarding the research, authorship and publication of this article.

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Design of Optimal Parameter for Solid-State Welding of EN 10028-P355 GH Steel Using gray Incidence Reinforced Response Surface Methodology

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Design of Optimal Parameter for Solid-State Welding of EN 10028-P355 GH Steel Using gray Incidence Reinforced Response Surface Methodology

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Abstract

EN 10028-P355 GH steel is normalized steel used in high-temperature applications including pipes carrying hot fluids. Fusion welding of such class of steels produces a larger heat affected zone, unwanted metallurgical changes and increased hardness in the weld area. The study explores the possibility of using a solid-state welding process (continuous drive friction welding) on EN 10028-P355 GH steel. The experimentation involves an L_{27} orthogonal array with the welding parameters like frictional pressure, forging pressure, friction time, forging time and rotational speed varied in three levels. The quality characteristics observed include the yield strength, tensile strength, axial shortening and impact toughness. The merits of gray theory are combined the statistical analysing capabilities of response surface methodology in an integrated approach of gray incidence reinforced response surface methodology to select the optimal friction welding inputs (frictional pressure-93.94 MPa, friction time-5.22 s, upset pressure-138.14 MPa, forging time-3.58 s and rotational speed-1282.67 rpm). The optimal friction welding inputs were validated with proper experiments, and microscopic images concerned with optimal bond is also analyzed. The study will offer the guiding database to weld EN 10028-P355 GH steel in solid-state using continuous drive friction welding.

Keywords EN 10028 GH steel · Continuous drive friction welding · Response surface methodology · gray theory · L_{27} orthogonal array

1 Introduction

The EN 10028-P355 GH steel finds its widespread applications in pressure vessels and boilers. The high tensile strength and impact toughness of EN 10028-P355 GH steel makes it a primary choice for tubes and pipes transporting hot fluids in heat exchangers. There are concerns in joining EN 10028-P355 GH steel using the conventional liquid state joining processes. The fusion welding techniques are characterized by the presence of a larger heat affected zone (HAZ) and consequent changes in the metallurgy of parent, producing corrosion at grain boundaries on a microscopic scale. This could affect the mechanical properties of joint, which is significant in applications at elevated temperature and stress. Hence, joining EN 10028-P355 GH steel in a solid-state could open up the possibilities of minimizing such unwanted mechanical and metallurgical changes. The temperature involved in solid-state processing is considerably lesser than the melting point of parent material hence producing a meager or zero HAZ. The continuous drive friction welding is a joining process employed to join tubes and pipes of both ferrous and non-ferrous materials. The process involves the generation of heat by mechanical rubbing (rotation) of one part with the other half of the joint. The desired rotational speed ensures a constant and continuous stirring at the weld interface and the applied upset pressure produces a bond with a certain amount of flash. Further the volume of material close to the weld interface alone is subjected to plastic deformation, restricting the axial shortening of joint. In the preliminary stages of the formation of a bond,

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the end of the rotating part was made tapered and inserted into a bore ring made of a material with good thermal resistance [1]. During the process, the plastic flow of material was observed at the joint interface. The mechanism regulating the plastic flow of material at the weld interface was important for controlling the amount of flash produced. A sound joint with a reasonably lesser flash was always desired to reduce axial shortening [2]. The observations patented by United Launch Alliance, Inc., had described the essential improvements in hardware employed to produce joints in solid-state [3]. A self-reacting pin tool was also proposed to eliminate the difficulties experienced in using a rigid and static tool in friction stir welding.

Friction welding was used to produce dissimilar steel joints with reasonably good strength and ductility compared to that of the parent material. The investigation revealed that the susceptibility of the weld area to failure under uniaxial loading as the weld interface was the weaker zone due to increased microhardness. The friction welding inputs including frictional pressure, upset pressure, burn off length and rotational speed were found to significantly influence the mechanical properties of joints [4, 5]. The design parameters in friction welding were varied to study their roles in the strength related aspects. The mechanical tests on joints had revealed a higher hardness in the plastic weld zone, while the microhardness variation was found to be lesser in the parent material [6, 7]. In the joints formed between AISI 4140 and AISI 1050 steels, the temperature rise was observed to play a vital role in affecting the quality characteristics of the bonds. The initial rise in temperature was found to be larger, followed by a steady rise with the continuous rotation, and the joints were formed with zero blank spaces [8]. Austenitic stainless steels known for weldability and corrosion resistance were produced with desirable mechanical properties friction welded at high temperatures [9]. Non-ferrous alloys could also be joined by friction welding and proper selection of process parameters could yield a joint efficiency of 89% in as-welded condition [10]. However, the dissimilar joints formed between aluminum and copper showed poor strength as a result of the accumulation of alloying elements and intermetallic compounds at the weld interface [11].

Generally, the friction welded interface included three different regions: unaffected zone, partially deformed zone and fully deformed recrystallized zone. Most of the microstructural changes were observed in the fully deformed and partially deformed zones [12]. A near-perfect bonding strength, close to that of parent material was possible by selecting proper values of friction time and rotational speed. The temperature distribution in the friction interface was mainly dependent on the welding parameters [13]. High strength nickel alloys joined using friction welding displayed a harder and stronger weld zone due to the formation of precipitates [14]. Dissimilar bonds involving maraging steel and low alloy steel were also formed using continuous drive friction welding. An interlayer of nickel was used as a diffusion barrier to improve the joint strength. The bonds were observed to respond to solutionizing and aging positively during post-weld heat treatment [15]. The tensile strength of steel joints increases with frictional pressure and friction time up to a certain level, but tend to decrease at higher values of these welding inputs. A similar trend was observed with the fatigue strength of joints [16]. Rotational speed and frictional pressure were found to influence the distribution of temperature and plastic flow of material at the weld interface. Optimal values of these welding inputs were observed to produce defect-free joints [17]. Hence, it is observed from the literature that superior quality characteristics of a joint depends primarily on the optimal selection of friction welding parameters like frictional pressure, friction time, upset pressure, forging time, burn off length and rotational speed.

Identifying the proper levels of various friction welding inputs could result in a joint with better quality characteristics. Hence, finding the optimal levels of design variables, their relationships with the responses and understanding the interaction among them is essential to form good joints. Design of experiment and evolutionary algorithms could be used to develop a mathematical relationship between the welding parameters and quality characteristics of the joint. The available literature had revealed a considerable interest in the application of response surface methodology (RSM) and artificial neural network to predict the responses. Optimization could be performed by using simulated annealing, genetic algorithm and particle swarm techniques. Among the three methods, genetic algorithm was observed to outperform the other methods [18]. Genetic algorithm was a good tool for experimental welding optimization even without a model for the process, however, difficulty was experienced in setting its parameters such as population size and number of generations for sufficient sweeping of search space. The technique of RSM technique was found to arrive at a better compromise between the evaluated responses though it struggles in the irregular experimental region [19]. The RSM technique was applied to find the optimal condition of friction welding parameters for joining dissimilar metals D3 tool steel and 304 austenitic stainless steel. The experimentation was based on Box–Behnken design to obtain the highest tensile strength [20]. The process parameters of friction welding were optimized using RSM for joining duplex stainless steel (DSS) UNS S32205. The central composite design (CCD) was used for experimentation. The upset pressure, friction pressure and speed of rotation were identified as most influencing parameters in maximizing the hardness and tensile strength [21, 22].

The application of hybrid techniques was employed for the optimization of process parameters and modeling the response values of various process. These integrated approaches have opened up the possibilities of combining the merits of the algorithms. The gray relational analysis was coupled with RSM technique for optimization and modeling of responses [22, 23]. The gray Taguchi-RSM was used for optimizing the friction welding parameters to join Al6061/SiC/Al_2O_3 metal matrix Composite [24]. It is a statistical tool used for optimization, and the technique is used to generate response surfaces to study the interaction effects of various design variables. Generally, Box–Behnken design and central composite design are used as the major response surface designs [23, 25, 26]. In a traditional RSM generating a quadratic response surface model for each of the responses, central composite design (CCD) or Box–Behnken design (BBD) is used for experimentation. This limits the study to the effects of design variables on single responses hence restricting the observations concerned with simultaneous optimization [27].

A considerable amount of literature is available in friction welding of similar and dissimilar materials of equivalent grade materials. An equivalent grade material, nuclear grade austenitic stainless steel 321 was joined by using a conventional TIG welding process, and their parameters were optimized using gray relational analysis to improve the mechanical properties of weld joints [28]. The effect of the heat input on the bead width and depth of penetration with various arc lengths was analyzed. The tensile strength measured at weld line (624 MPa) was observed higher than that of base metal (621 MPa). The flux activated—TIG welding process was employed for joining a square-groove butt weld joint of modified 9Cr–1Mo steel and the influence of MnO_2 flux activation on mechanical and metallurgical properties was analyzed. The activated TIG welding improved the depth of penetration and depth-to-width ratio (D/W) compared to the TIG welding process [29]. The Fe–2.25Cr–1Mo steel tube was joined with carbon steel tube using TIG welding process with the application of chromium containing filler material. The formation of Cr_2O_3 due to chromium content improved the corrosion resistance behavior of the weld [30]. The literature related to solid-state joining of EN 10028-P355 GH steel are not enough even the material has major applications in heat exchanger tubes. Further, little attention is observed in welding parameter design involving EN 10028-P355 GH steel within the scientific literature. Hence, the work explores the possibility of forming good quality welded joints using continuous drive friction welding with the objective of offering the guidelines and welding database for joining EN 10028-P355 GH steel using friction welding process. Though applications of RSM with central composite design are available in manufacturing processes, orthogonal arrays-based RSM is limited in the literature. Hence, the scope for simultaneous optimization of multiple responses is widened in the proposed work by application of an integrated approach of gray incidence reinforced response surface methodology for optimal parameter design.

2 Material and Experimental Procedure

2.1 Machine and Material

The EN 10028-P355 GH steel used as heat exchanger tubes is procured in the form of a normalized steel rod of diameter 16 mm. The chemical composition of parent material is as follows: Mn-1.10%, C-0.18%, Si-0.50%, Cr-0.30%, Mo-0.08%, Ni-0.5%, V-0.10, Cu-0.30%, S-0.01% and Fe-remaining. The rods machined to lengths of 130 mm each are subjected to friction welding in a continuous drive friction welding machine (Model: FW-6T) manufactured by RV machine tools, Coimbatore, India. The machine houses a hydraulic chuck with a spindle driven at a maximum speed of 3000 rpm and rated at 12 kW. The servomotor gearbox is used for slide drive, and the friction welding parameters are precisely set by 'Indra Control VCP-02' at the operator terminal. The machine has an inbuilt unit of the 'Rexroth controller' manufactured by the automation assembly unit of Bosch Rexroth, Germany (Fig. 1a, b).

(a) (b)

Figure 1 **a** Friction welding machine, **b** operator terminal

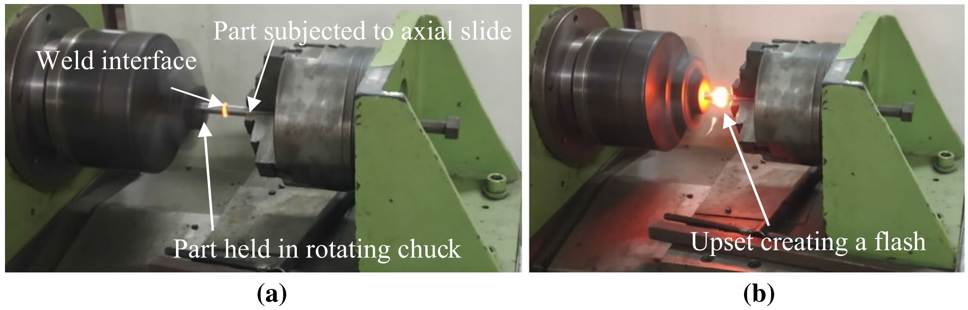

Figure 2 **a** Application of frictional pressure in the initial phase, **b** upset and formation of flash.

Table 1 Levels of various friction welding inputs

Friction welding inputs	Symbol	Unit	Levels of parameters		
			Level 1	Level 2	Level 3
Frictional pressure	A	MPa	70	90	110
Upset pressure	B	MPa	100	120	140
Frictional time	C	s	3	5	7
Forging time	D	s	3	5	7
Rotational speed	E	rpm	1000	1200	1400

Fig. 3 Sample joints formed during friction welding

2.2 Experimentation

During friction welding, one half of the joint was attached to spindle drive, precisely controlled by Rexroth while the other half is held stationary and impending to slide. The two parts are allowed to get in contact after ensuring equal overhang on both the parts to be joined. With the required setting of parameters, a smooth transition is ensured across different phases of the formation of joint. Figure 2a, b shows the initial phase, upset and formation of flash at weld interface during the process of friction welding. The predominant welding parameters used in experimentation include the frictional pressure, friction time, upset pressure, forging time and rotational speed [20, 21]. These parameters affect the temperature, and hence, the plastic flow at weld interfaces determining the joint characteristics [4, 6, 8, 16, 22]. The levels of various parameters were found out using the preliminary experimental trials resulting in bonds without any defects/failure on visual inspection. Trials for determining the range of various parameters were conducted based on pre guidance from scientific literature. Table 1 displays the levels of various welding parameters used in experimentation.

Taguchi's orthogonal array (L_{27}) was used to conduct the experiments, which opens the possibility of studying the necessary interaction effects among various design variables [27]. The quality characteristics include the yield strength (YS), ultimate tensile strength (UTS), axial shortening (AS) and impact toughness (IT). To reduce the effects of uncontrollable factors, the trials were conducted at random [20] with necessary replications, and the formed joints were observed for the quality characteristics. The sample joints formed during experimentation are shown in Fig. 3.

The tension test was performed in Instron-Computerized tension tester after preparing the specimen as per the ASTM E8 standard. The layout of specimen for tensile testing is shown in Fig. 4. A few samples of tensile specimen before and after testing are shown in Fig. 5. Failure was observed near the weld interface in most of the samples subjected to tension tests.

Axial shortening was measured as the decrease in length of the final joint obtained at the end of the friction welding process. Impact toughness was primarily studied to observe the effect of larger deformation speeds on the material. The amount of energy absorbed by the specimen during fracture, as observed from the impact test gives a toughness measure of samples. This offers the scope for further studies related to the ductile–brittle transition. Charpy V-notch testing (pendulum type) is performed to find the energy absorbed by samples on dynamic loading as per ASTM E23 standard. The layout of specimen for impact testing is shown in Fig. 6. The sample specimen for the Charpy V-notch test after failure is shown in Fig. 7. The quality characteristics observed in various friction

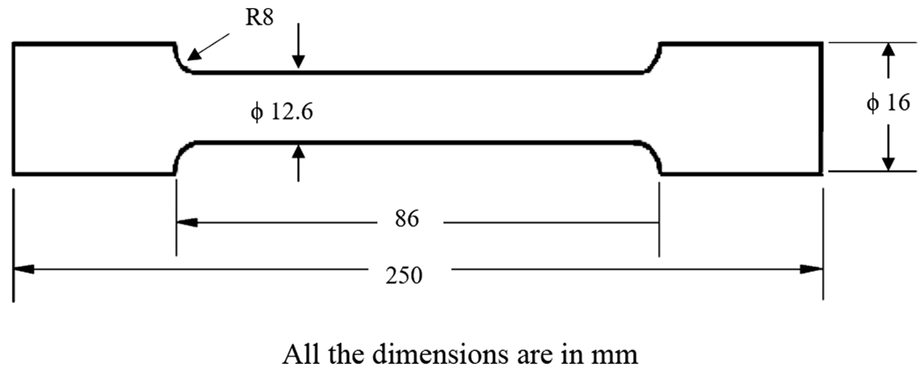

Fig. 4 Layout of specimen for tensile testing

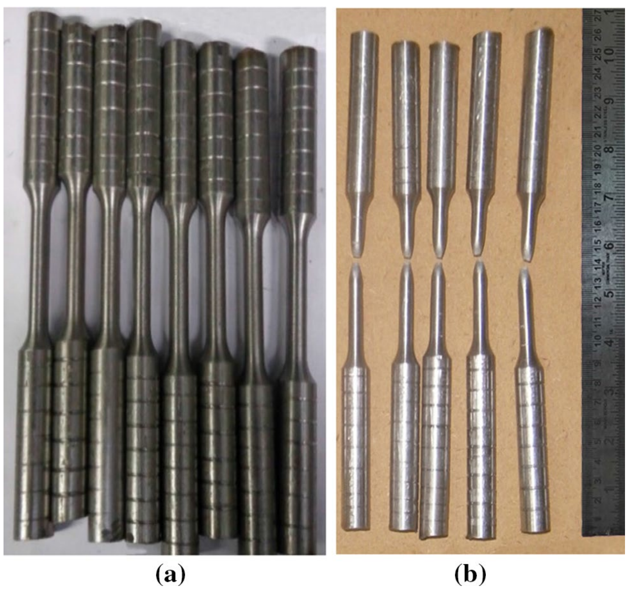

Fig. 5 Samples **a** before tension test, **b** after tension test

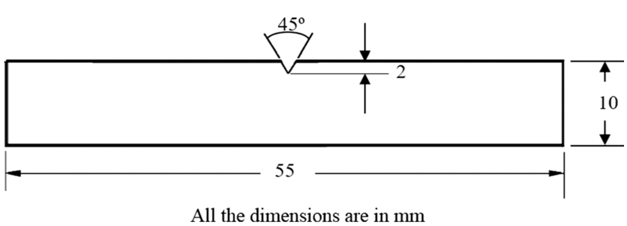

Fig. 6 Layout of specimen for Charpy V-notch test

Fig. 7 Specimen subjected to Charpy V-notch test

welded joints formed using different combinations of welding inputs (L_{27} orthogonal array) is shown in Table 2.

3 gray Incidence Reinforced Response Surface Methodology

RSM is a statistical approach with a module for modeling the design variables and desirability analysis for optimizing the responses. The effects of parameters on responses are illustrated by 3D surface graphs. The integrated strategy of gray incidence reinforced response surface methodology combines the uncertainty handling ability of gray incidence analysis with the modeling abilities of RSM. The multiple responses observed via experimentations are transformed into a single measure of quality as gray relational grade (GRG). It is used for further modeling using RSM and simultaneous optimization of the welding inputs (design variables). The various steps in gray incidence reinforced response surface methodology are presented in two stages.

3.1 Part I: gray Incidence Analysis

During the first stage of gray incidence, the experimental data are processed by calculating the reciprocal of coefficient of variation termed as the 'signal-to-noise' (S/N) ratio. The normalized S/N ratio converts experimental data in the range of zero to one. The processed data are further analyzed by forming gray relational grade and projecting it as the single representative of various outputs obtained from experimentations. The various steps are discussed below.

Step 1 Estimate the S/N ratio (η_{ij}) for each output using the appropriate equation based on its quality characteristics. The three formats in which an output are analyzed include the following: *nominal-the-best, smaller-the-better or larger-the-better*. A *nominal-the-best* characteristic has a user-defined target value. The target of *smaller-the-better* characteristic is attaining a minimum value of response (zero), while a *larger-the-better* characteristic has a target of infinity i.e. attaining a

Table 2 Levels of various friction welding inputs and observed responses

Trial order	Friction welding inputs						Responses							
Actual	Random	*A*	*B*	*C*	*D*	*E*	YS (MPa)		UTS (MPa)		AS (mm)		IT (J)	
1	7	70	100	3	3	1000	281.95	282.55	483.02	485.10	10.50	10.67	14	15
2	23	70	100	5	5	1200	304.35	304.75	501.60	503.60	16.80	16.63	18	18
3	3	70	100	7	7	1400	314.46	314.06	551.55	553.55	21.10	22.93	21	20
4	4	70	120	3	5	1400	286.54	287.14	525.70	525.70	15.80	15.97	17	17
5	17	70	120	5	7	1000	276.13	275.73	548.55	548.55	22.70	22.70	18	16
6	22	70	120	7	3	1200	290.82	291.54	563.35	562.35	16.20	16.37	19	19
7	2	70	140	3	7	1200	305.39	305.79	592.80	593.80	22.20	22.37	19	18
8	8	70	140	5	3	1400	300.24	300.24	542.80	540.80	20.90	21.07	21	22
9	12	70	140	7	5	1000	310.48	310.88	578.05	576.05	24.80	24.80	20	20
10	14	90	100	3	3	1000	308.25	307.85	584.25	585.25	12.60	12.27	17	18
11	27	90	100	5	5	1200	316.24	316.24	587.10	588.10	17.80	17.80	19	20
12	9	90	100	7	7	1400	320.15	319.55	599.45	600.45	23.60	23.77	22	21
13	25	90	120	3	5	1400	319.51	319.11	581.68	582.95	20.90	20.90	20	20
14	26	90	120	5	7	1000	320.27	320.67	575.70	576.70	21.40	21.07	19	18
15	13	90	120	7	3	1200	313.54	313.74	586.15	589.15	22.40	22.23	20	20
16	16	90	140	3	7	1200	317.87	317.47	584.25	586.25	23.20	23.20	21	22
17	20	90	140	5	3	1400	319.26	319.26	570.10	570.10	20.40	20.40	22	22
18	15	90	140	7	5	1000	319.77	319.97	548.55	547.55	22.10	22.77	20	21
19	5	110	100	3	3	1000	304.14	303.94	549.10	551.10	15.70	15.37	17	17
20	10	110	100	5	5	1200	319.27	319.87	581.40	582.40	21.90	21.23	18	20
21	18	110	100	7	7	1400	330.65	330.85	602.15	601.23	24.60	25.37	21	18
22	6	110	120	3	5	1400	321.54	321.14	600.40	598.40	22.80	22.37	19	18
23	1	110	120	5	7	1000	308.47	309.07	557.55	559.55	21.60	21.27	17	17
24	11	110	120	7	3	1200	319.67	319.67	606.10	605.10	22.70	22.03	18	18
25	24	110	140	3	7	1200	309.82	309.82	593.95	596.95	20.90	21.07	20	18
26	21	110	140	5	3	1400	312.52	311.92	605.15	606.15	25.70	25.87	22	20
27	19	110	140	7	5	1000	310.84	310.44	578.40	579.40	24.20	24.37	20	22

maximum value of output. The S/N ratio (η_{ij}) for such characteristics is calculated by using Eqs. (1) and (2).

$$\text{Smaller-the-better characteristic:} \quad \text{S/N Ratio}(\eta) = -10\log_{10}\left(\frac{1}{r}\cdot\sum_{i=1}^{r} y_{ij}^2\right) \tag{1}$$

$$\text{Larger-the-bettercharacteristic:} \quad \text{S/N Ratio}(\eta) = -10\log_{10}\left(\frac{1}{r}\right)\sum_{i=1}^{r}\frac{1}{y_{ij}^2} \tag{2}$$

where y_{ij} = observed response values, i = 1, 2, 3 … r, and j = 1, 2, … m, r = number of replications, m = number of observations.

Step 2 Estimate the normalized S/N ratio (Z_{ij}) using Eq. (3) to reduce the variability among the calculated values of S/N ratio for various responses. 'n' represents the number of trials.

$$Z_{ij} = \frac{y_{ij} - \min(y_{ij}, i = 1, 2, \ldots, n)}{\max(y_{ij}, i = 1, 2, \ldots, n) - \min(y_{ij}, i = 1, 2, \ldots, n)} \tag{3}$$

Step 3 calculate the gray incidence coefficient (γ) from the normalized S/N ratio values using Eq. (4)

$$\gamma_i^j = \frac{\Delta\min + \xi\Delta\max}{\Delta_{oj}(i) + \xi\Delta\max} \tag{4}$$

where $i=1, 2\ldots n$ and $j=1,2\ldots m$, n is the number of responses and m is the number of trials.

$\Delta_{oj} = \left\| z_o(i) - z_j(i) \right\|$, $z_o(i)$ is the reference sequence ($z_o(i)=1$; $i=1,2,\ldots,n$) and $z_j(i)$ is the specific comparison sequence.

$\Delta \min = \min_{\forall j \in i} \min_{\forall i} \left\| z_o(i) - z_j(i) \right\|$ is the smallest value of $z_j(i)$, $\Delta \max = \max_{\forall j \in i} \max_{\forall i} \left\| z_o(i) - z_j(i) \right\|$ is the largest value of $z_j(i)$, and 'ξ' is the distinguishing coefficient whose value is taken as 0.25.

Step 4 Find the GRG values (γ_i) for every trial using Eq. (5)

$$\mathrm{GRG}_i = \frac{1}{n}\sum_{i=1}^{n}(\gamma_i). \quad (5)$$

3.2 Part II: GRG Reinforced RSM

The GRG value for various trials is seen as a single quality measure representing various responses. The GRG value for various experimental conditions is used in the RSM technique as a single response and a polynomial model for GRG value is generated. The response surfaces plots are also generated to observe the influence of welding inputs.

Step 5 Execute the analysis of variance (ANOVA) using GRG values to find the significant contribution of welding inputs.

Step 6 Develop a quadratic model to relate the GRG with various inputs and their interactions. Test the model fitness with the experimental data.

Step 7 Plot the response surfaces (3D) graphs to study the effects of various welding inputs on GRG and use desirability analysis to find the optimal welding condition. Validate the same via experimentations.

4 Results and Discussion

4.1 gray Incidence Analysis and GRG Values

gray incidence analysis was performed using the gray theory which uses S/N ratio as the preliminary index and gives solutions that are more appropriate to real-world problems [20]. The three quality characteristics studied via experimentations (YS, UTS and IT) were treated as 'larger-the-better' characteristics with an intended magnitude of one, while the fourth response (AS) was analyzed as the 'smaller-the-better' characteristic with a desired value of zero. The calculated S/N values of various responses were subjected to linear normalization to align those towards normal distribution and make the values of design variables more comparable. The normalized values of S/N ratios are presented in Table 3. The GRG values were obtained using the GRC values calculated using Eq. (6). The GRG functions as a representative for the various measured responses, deserving a higher value regardless of their nature. The variations in GRG values for the 27 experimental trials are described graphically in Fig. 8. The maximum observed value of GRG was 0.6370 (21st trial), indicating a closer proximity of the experimental conditions to a near-optimal one.

4.2 Second-Order Polynomial for GRG (Fitness and Adequacy)

The methodology of RSM uses a mathematical technique for model building. The design variables used in friction welding were mapped with the quality characteristics observed in solid-state joints in terms of GRG. A quadratic model [Eqs. (6), (7)] which was a polynomial of order two was formed to relate the various welding inputs with GRG using Design-Expert software. The formulated model includes both individual and interaction effects of various welding inputs on GRG thus offering the scope to observe the mathematical behavior within the system. Equations (6, 7) represent the representative of responses (GRG) in terms of coded and actual factors respectively. The insignificant terms were excluded (model reduction) to make it less expensive computationally, but preserving the closeness and stability of actual model [20]. A considerable reduction in the number of experimental trials was realized with the L_{27} orthogonal array compared to the conventional experimental designs (CCD/BBD) used with RSM [27].

$$\begin{aligned}\mathrm{GRG} = {} & +0.50 + 0.054 \times A + 0.057 \times B + 0.064 \\ & \times C - 0.043 \times D + 0.052 \times E + 0.020 \\ & \times A \times C + 0.045 \times A \times E - 0.082 \times B \times C \\ & + 0.080 \times B \times D + 0.091 \times C \times D - 0.076 \times A^2\end{aligned}$$

$$\begin{aligned}\mathrm{GRG} = {} & +0.014862 + 0.020672 \times A + 3.03400 \times 10^{-3} \\ & \times B + 0.11713 \times C - 0.37594 \times D - 7.58611 \times 10^{-4} \\ & \times E + 5.01554 \times 10^{-4} \times A \times C + 1.13312 \times 10^{-5} \\ & \times A \times E - 2.04031 \times 10^{-3} \times B \times C + 2.00232 \times 10^{-3} \\ & \times B \times D + 0.022870 \times C \times D - 1.89203 \times 10^{-4} \times A^2\end{aligned}$$

Analysis of variance (Table 4) was carried out to study the model adequacy and fitness in relating the welding inputs with GRG [23, 24]. This could help in understanding the importance of model coefficients identified using Design–Expert software in forming a technical link with responses represented by GRG. The polynomial model was found to be significant with an F value of 14.97 and a p value of less than 0.0001, declaring the minimal effects of noise factors. The p value probability less than 0.05 indicates the substantial importance of all the terms in the model including frictional pressure (A), upset pressure (B), friction time

Table 3 Calculations leading to the performance index

Trial	S/N ratio				Normalized S/N ratio				gray relational co-efficient (GRC)				GRG
	YS	UTS	AS	IT	YS	UTS	AS	IT	YS	UTS	AS	IT	
1	49.013	53.697	− 20.493	23.212	0.125	0.000	1.000	0.000	0.222	0.200	1.000	0.200	0.4055
2	49.673	54.024	− 24.463	25.105	0.545	0.168	0.487	0.521	0.354	0.231	0.327	0.343	0.3139
3	49.946	54.847	− 26.863	26.227	0.718	0.591	0.176	0.829	0.470	0.379	0.233	0.594	0.4189
4	49.153	54.415	− 24.019	24.609	0.214	0.369	0.544	0.384	0.241	0.284	0.354	0.289	0.2919
5	48.816	54.784	− 27.121	24.564	0.000	0.558	0.143	0.372	0.200	0.361	0.226	0.285	0.2679
6	49.283	55.008	− 24.235	25.575	0.297	0.673	0.516	0.650	0.262	0.433	0.341	0.417	0.3632
7	49.703	55.465	− 26.960	25.334	0.563	0.908	0.164	0.584	0.364	0.731	0.230	0.375	0.4251
8	49.549	54.677	− 26.438	26.642	0.466	0.503	0.231	0.943	0.319	0.335	0.245	0.815	0.4284
9	49.846	55.224	− 27.889	26.021	0.655	0.784	0.044	0.772	0.420	0.537	0.207	0.523	0.4218
10	49.772	55.339	− 21.893	24.850	0.608	0.843	0.819	0.450	0.389	0.615	0.580	0.313	0.4741
11	50.000	55.382	− 25.008	25.792	0.752	0.865	0.416	0.710	0.502	0.649	0.300	0.463	0.4785
12	50.099	55.562	− 27.489	26.642	0.815	0.958	0.095	0.943	0.575	0.856	0.217	0.815	0.6154
13	50.084	55.303	− 26.403	26.021	0.806	0.825	0.236	0.772	0.563	0.588	0.247	0.523	0.4801
14	50.116	55.211	− 26.541	25.334	0.826	0.778	0.218	0.584	0.589	0.529	0.242	0.375	0.4339
15	49.929	55.382	− 26.973	26.021	0.707	0.865	0.162	0.772	0.460	0.650	0.230	0.523	0.4658
16	50.040	55.347	− 27.310	26.642	0.777	0.847	0.119	0.943	0.529	0.621	0.221	0.815	0.5463
17	50.083	55.119	− 26.193	26.848	0.805	0.730	0.263	1.000	0.562	0.481	0.253	1.000	0.5739
18	50.099	54.776	− 27.019	26.227	0.815	0.554	0.156	0.829	0.575	0.359	0.229	0.594	0.4393
19	49.659	54.809	− 23.826	24.609	0.535	0.571	0.569	0.384	0.350	0.368	0.367	0.289	0.3434
20	50.091	55.297	− 26.677	25.539	0.810	0.822	0.200	0.640	0.568	0.584	0.238	0.410	0.4501
21	50.390	55.587	− 27.954	25.724	1.000	0.971	0.035	0.691	1.000	0.895	0.206	0.447	0.6370
22	50.139	55.554	− 27.076	25.334	0.841	0.954	0.149	0.584	0.611	0.844	0.227	0.375	0.5141
23	49.793	54.941	− 26.622	24.609	0.621	0.639	0.207	0.384	0.397	0.409	0.240	0.289	0.3337
24	50.094	55.644	− 26.993	25.105	0.812	1.000	0.160	0.521	0.571	0.999	0.229	0.343	0.5353
25	49.822	55.497	− 26.438	25.539	0.639	0.924	0.231	0.640	0.409	0.767	0.245	0.410	0.4579
26	49.889	55.644	− 28.227	26.415	0.682	1.000	0.000	0.881	0.440	1.000	0.200	0.677	0.5792
27	49.845	55.252	− 27.706	26.415	0.654	0.799	0.067	0.881	0.419	0.554	0.211	0.677	0.4653

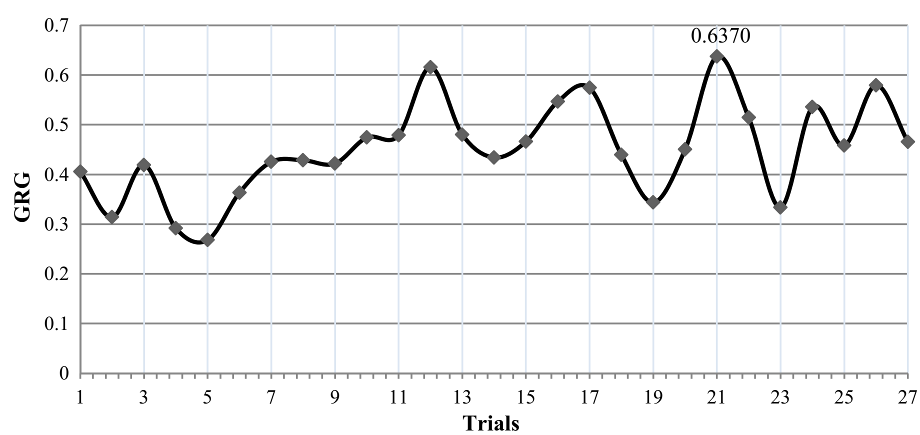

Fig. 8 Plot of GRG values for different experimental trials

(C), forging time (D), rotational speed (E) and their interactions (AE, BC, BD and CD). Second-order of term A (frictional pressure) was also found to be significant in influencing the GRG and hence the responses. The quadratic model was capable of simulating the solid-state friction welding conditions in EN 10028-P355 steel.

The *R*-squared value (coefficient of determination) and adequate precision value is shown in Table 5. The *R*-squared value is a statistical measure to understand the closeness

Table 4 ANOVA for response surface quadratic model

Source	Sum of squares	Degrees of freedom	Mean sum of square	F value	p value	Remarks
Model	0.212782	11	0.019344	14.97374	< 0.0001	Significant
A—Frictional pressure	0.053276	1	0.053276	41.23997	< 0.0001	
B—Upset pressure	0.025479	1	0.025479	19.723	0.0005	
C—Friction time	0.020368	1	0.020368	15.76649	0.0012	
D—Forging time	0.009158	1	0.009158	7.089374	0.0177	
E—Rotational speed	0.007017	1	0.007017	5.431853	0.0341	
AC	0.00483	1	0.00483	3.73874	0.0723	
AE	0.024652	1	0.024652	19.08267	0.0006	
BC	0.011656	1	0.011656	9.0228	0.0089	
BD	0.011226	1	0.011226	8.689914	0.0100	
CD	0.029291	1	0.029291	22.67372	0.0003	
A^2	0.034366	1	0.034366	26.60214	0.0001	
Residual	0.019378	15	0.001292			
Cor total	0.232159	26				

Table 5 Coefficient of determination and model discrimination

SD	0.036	R-squared	0.9378
Mean	0.45	Adj R-squared	0.8553
C.V. %	7.98	Pred R-squared	0.7114
PRESS	0.067	Adeq precision	14.205

of data to the regression line. A higher value of the coefficient of determination (greater than 0.7) is desired to ensure better fitness of the generated model to experimental data. The R-squared value of 0.9378, nearer to unity ensures a good fit between the generated polynomial equation and data measured within the welding domain. Though the predicted R-squared value (0.7114) was observed to be lesser than the adjusted R-squared value (0.8553), it proves the capability of the model to predict the response for a new set of observations in welding inputs. The predicted R-squared value (0.7114) observed from Table 5 was reasonable in preventing an overfit model, which would explain noise otherwise. Adequate precision could compare the range of predictions from the polynomial model to the associated errors. Adequate Precision was observed to be 14.205 (a value greater than 4 is desired), which proves the sufficiency in model discrimination in terms of signal adequacy. Hence the generated polynomial equation can be deemed fit and adequate in describing the relationship between the welding inputs and response represented in terms of GRG.

The closeness of actual and predicted values of response (GRG) for the 27 trials is shown in Fig. 9 (Plot of the predicted versus actual GRG values). The points are closer to the diagonal regression line without a foggy pattern proving the model fitness [24]. The plot of internally studentized

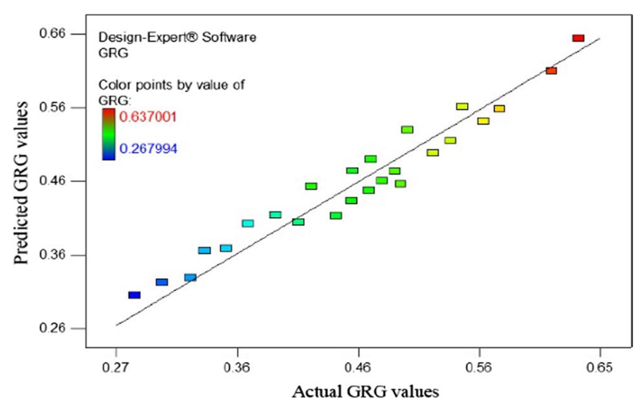

Fig. 9 Scatter plot of predicted versus actual GRG values

residuals is shown in Fig. 10. It considers the difference in predicted and observed values of GRG along with the standard deviation. The majority of the residuals are observed to be positive or along the diagonal line with an almost symmetric distribution without any clear patterns. The randomness in the residual plot further ascertains the fitness of the generated model for the response.

4.3 Analysis of Response Surface Plots

The various welding parameters including the frictional pressure, friction time, upset pressure, forging time and rotational speed, along with their interactions were observed to influence the yield strength, tensile strength, impact toughness and axial shortening significantly. Frictional pressure along with a defined rotational speed helps in creating the required temperature at the weld interface. The heat generation at the

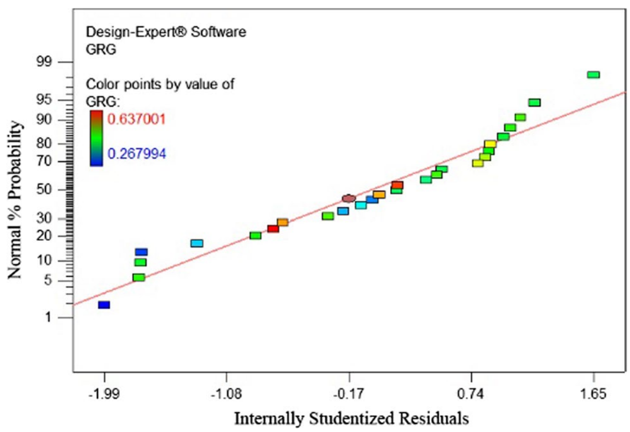

Fig. 10 Plot of studentized residuals to ascertain fitness

localized region is due to the rubbing action of irregularities in the mating surface. The constant frictional pressure ensures flattening of irregularities at the weld interface eliminating surface preparation in friction welding. A moderate value of frictional pressure (93 MPa) was observed to produce a better response as observed from the response surface plots (Fig. 11a, b). However, a moderate level of friction time (5.22 s) was desired to generate the heat and necessary temperature at the interface (Fig. 11b–d). A higher value of upset pressure (138 MPa) was found to produce a larger GRG (Fig. 11c, e) and hence, an improved response. The effect of upset along with the frictional energy input softens the materials assuring a plastic flow at the interface in the form of flash creating a good bond. When the forging pressure was maintained for more time, a considerable axial shortening was observed, and GRG was observed to decrease. Increased forging time allows for more heat dissipation in lesser time by increasing the surface area of flash. This could cause an increased hardness at the weld interface area. Hence, a small forging time was desired as observed from the plots (Fig. 11d, e). Also heat transfer by forced convective mode was realized at higher rotational speeds resulting in temperature drop at an increased rate. Hence, a moderate value of rotational speed (1282 rpm) was observed to be effective in producing better response (Fig. 11a).

4.4 Desirability Analysis on GRG Values and Ramp Graph

The technique of desirability analysis uses a desirability function to identify the scale-free value of desirability for the various responses [27]. The desirability function used in analysis of the calculated GRG values is of 'larger-the-better' type which forms the individual values of desirability ranging from zero to one. The combination of friction welding inputs producing the maximum value of desirability was identified and marked as the near-optimal condition (frictional pressure-93.94 MPa, friction time-5.22 s, upset pressure-138.14 MPa, forging time-3.58 s and rotational speed-1282.67 rpm). The outcome of desirability analysis is presented in Table 6. The ramp graph with optimal levels of welding inputs is shown in Fig. 12. The ramp graphs of individual welding inputs are combined and presented for the greatest overall desirability. The red dot on each ramp shows the most desired level of each welding input within the range chosen for experimental trials, hence representing the highest value of GRG (0.6508).

4.5 Welding Trial Using Predicted Optimal Values of Inputs

A proper experimental endorsement of near-optimal setting of friction welding inputs (frictional pressure-93.94 MPa, friction time-5.22 s, upset pressure-138.14 MPa, forging time-3.58 s and rotational speed-1282.67 rpm) becomes important to validate the approach of gray incidence reinforced response surface methodology and confirm the improvement in the observed quality characteristics. The outputs of experimental trial (No. 21) with the largest calculated value of GRG (0.6370) were compared with outputs obtained with the optimal setting of welding inputs predicted by gray incidence reinforced response surface methodology. Improvements were observed in the quality characteristics of the joint formed with optimal welding inputs substantiating the approach adopted for multi-response optimization. The properties of joint obtained with optimal parameters are YS = 339.42 MPa, UTS = 612.21 MPa and IT = 27 J, and properties of base metal are YS = 292 MPa, UTS = 528 MPa, IT = 23.90 J. It was observed that the YS and UTS are appeared higher than the values observed at base metal. The improvement in impact toughness appears minimal, but still the value (23.90 J) appears closer to the impact toughness value of parent material (27 J), during Charpy V-notch testing. The axial shortening obtained with the optimal setting of welding inputs was not significantly remarkable (20.75 mm). However, tensile strength and impact toughness were observed to be good at moderate/higher values of axial shortening. Hence, a good bond which promises good mechanical properties can be obtained with only reasonable values of shortening (Table 7).

4.6 Macroscopic and Microscopic Examination of Optimal Joint

The joint formed with an optimal welding input setting is shown in Fig. 13a, b. The heat flux generated due to frictional pressure and rotational speed creates the necessary thermal input for the softening of material closer to the weld interface. The application of optimal upset pressure creates

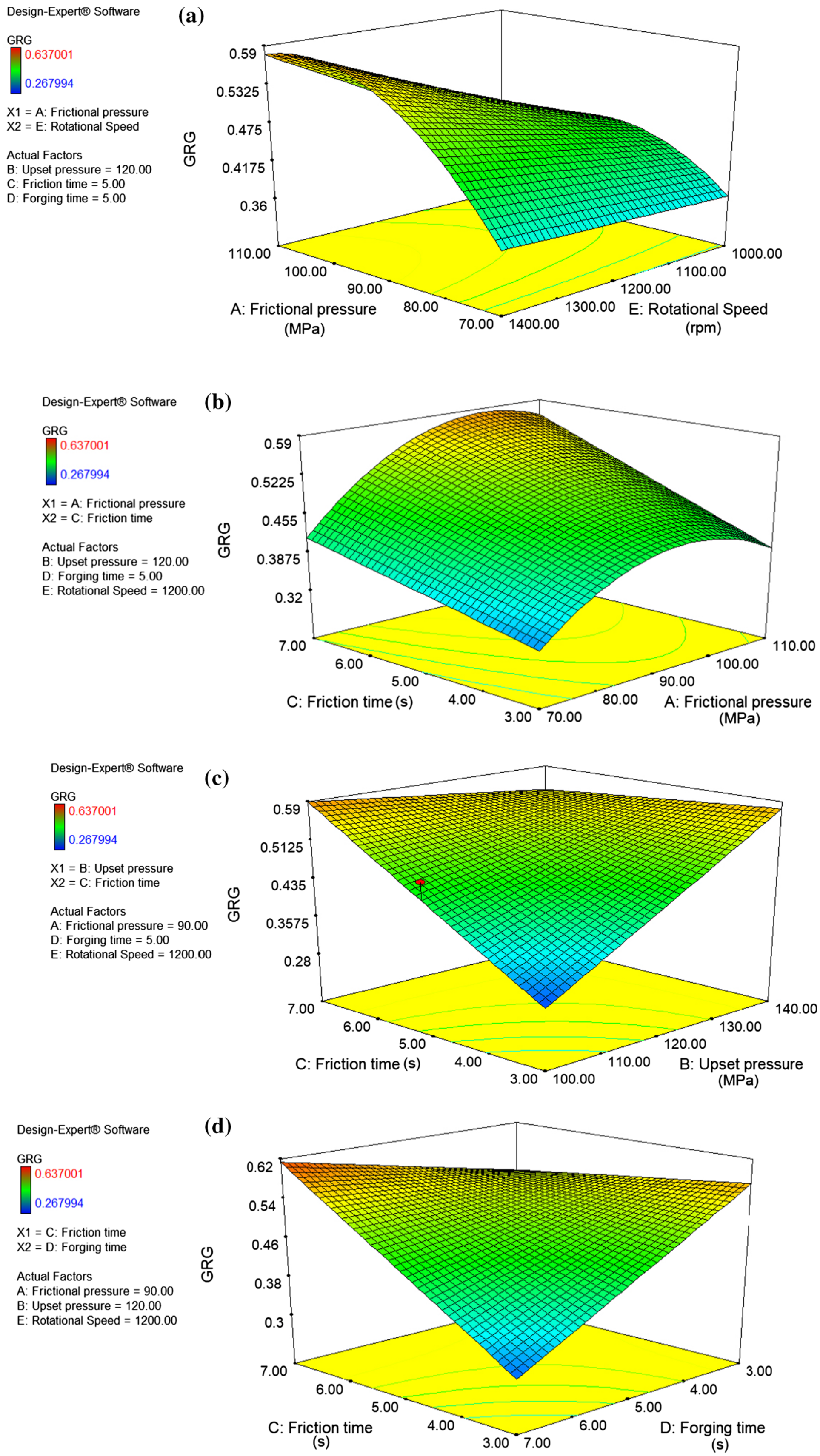

Fig. 11 Response surface plots displaying the parameter effects on GRG, **a** frictional pressure and rotational speed, **b** friction time and frictional pressure, **c** friction time and upset pressure, **d** forging time and friction time, **e** upset pressure and forging time

Fig. 11 (continued)

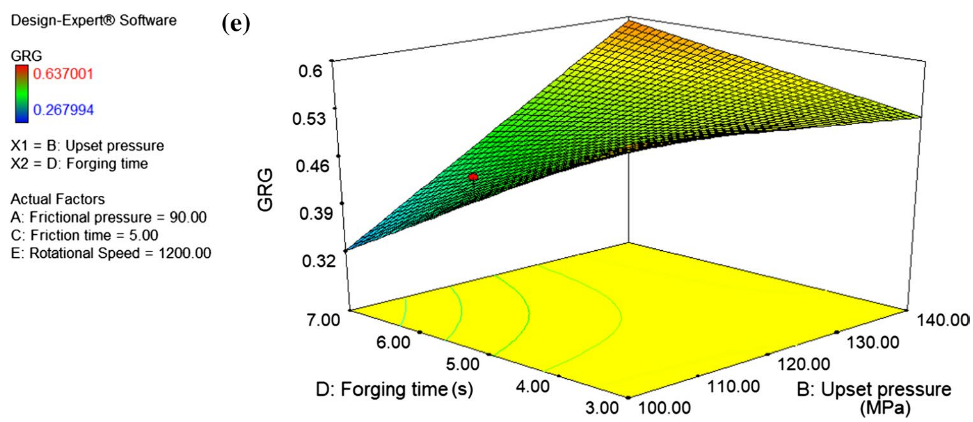

Table 6 Optimal levels of friction welding inputs

Symbol	Welding inputs	Optimal level	Low level	High level
A	Frictional pressure	93.944	70	110
B	Upset pressure	138.147	100	140
C	Frictional time	5.22	3	7
D	Forging time	3.58	3	7
E	Rotational speed	1282.67	1000	1400
Response	Prediction	SE mean	95% CI low	95% CI high
GRG	0.65088	0.06041	0.520419	0.780006

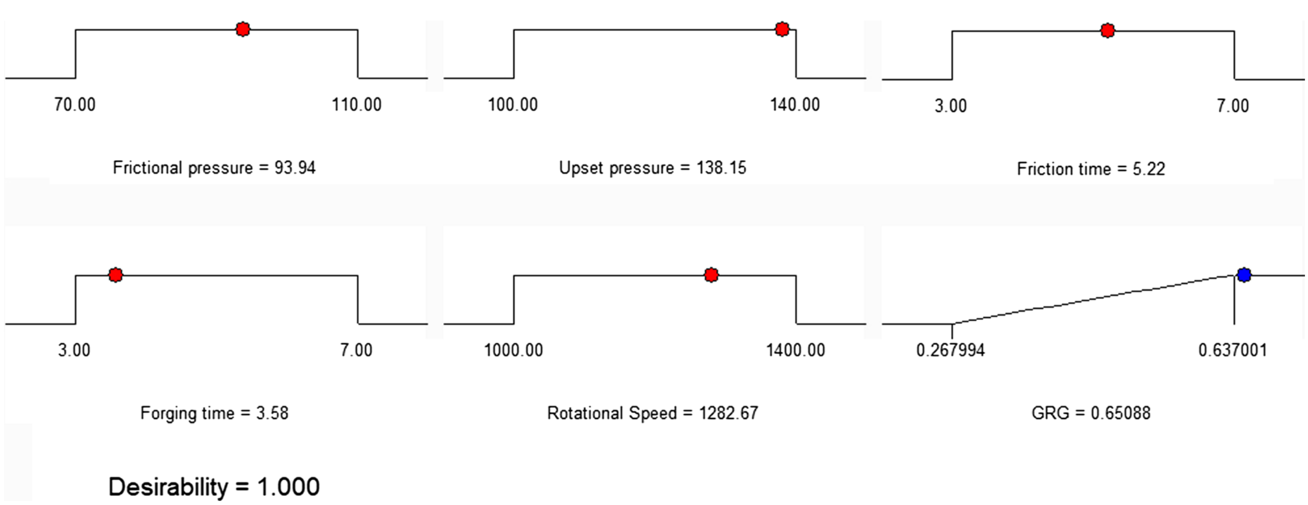

Fig. 12 Ramp graph with optimal level of friction welding inputs

Table 7 Responses obtained with optimal friction welding inputs

Responses	Initial setting	Optimal setting	Enhancement
GRG	0.637	0.65088	0.01388
Yield strength (MPa)	330.62	339.42	8.80
Ultimate tensile strength (MPa)	600.54	612.21	11.67
Axial shortening (mm)	24.15	20.75	3.40
Impact toughness (J)	21.70	23.90	2.20

plastic movement of material closer to interface radially outwards in the form of flash. The curl of parent material in the form of flash was evident, and the weld penetration was thoroughly complete as the weld line was not visible in Fig. 13b. Macroscopic examination further reveals the uniform width of flash, portraying the goodness of bond. The stereo microscope (model SZX16) equipped with DP series digital camera, and an inbuilt imaging software was used to analyse the microstructural characteristics near the weld area (Figs. 14, 15). The weld zone including the interface is seen along with the advancing and receding parts of the joint.

The microstructure of the tensile and impact specimen formed from the bonds with optimal parameter setting is shown in Fig. 14a, b. In both the microstructures, a small amount of pearlitic phase and predominantly ferritic phases are seen. However, pearlite itself is made of ferritic and cementite bonds [6, 8]. The grains appear to be pulled along the direction of uniaxial loading in tensile specimen (Fig. 14a), however, a relatively equi-axed grain is seen in impact specimen (Fig. 14b).

The region circled in Fig. 15a is enlarged to make a clear picture of the different zones near the weld area. Three different regions observed near the weld area

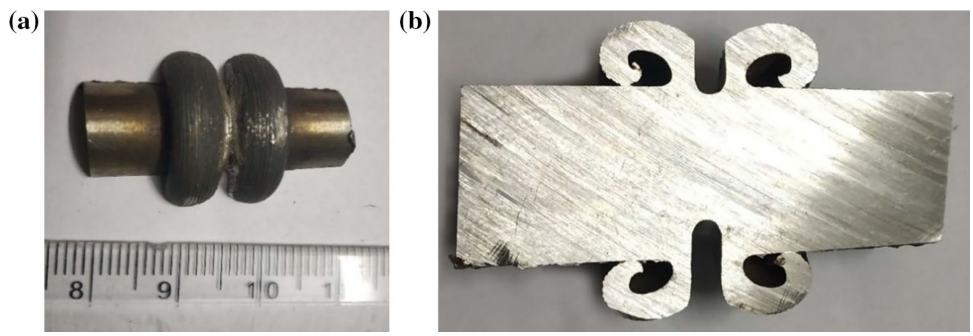

Fig. 13 **a** Weld interface of optimal joint, **b** longitudinal cut section revealing flash.

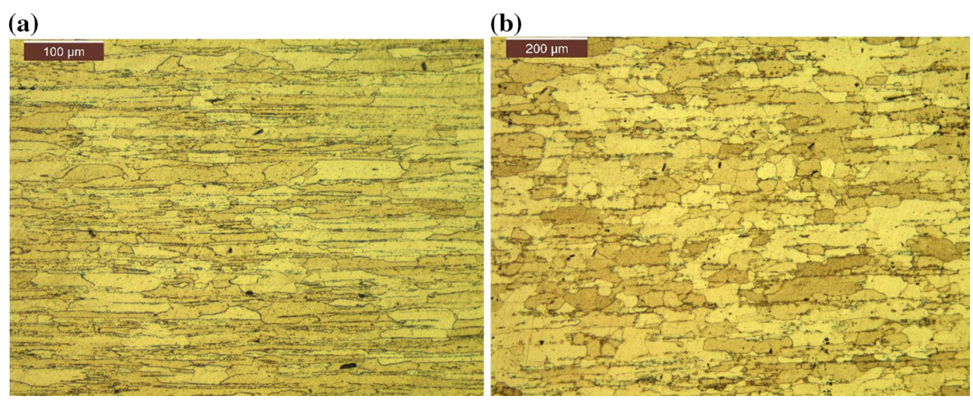

Fig. 14 Microstructure of **a** tensile specimen, **b** impact specimen

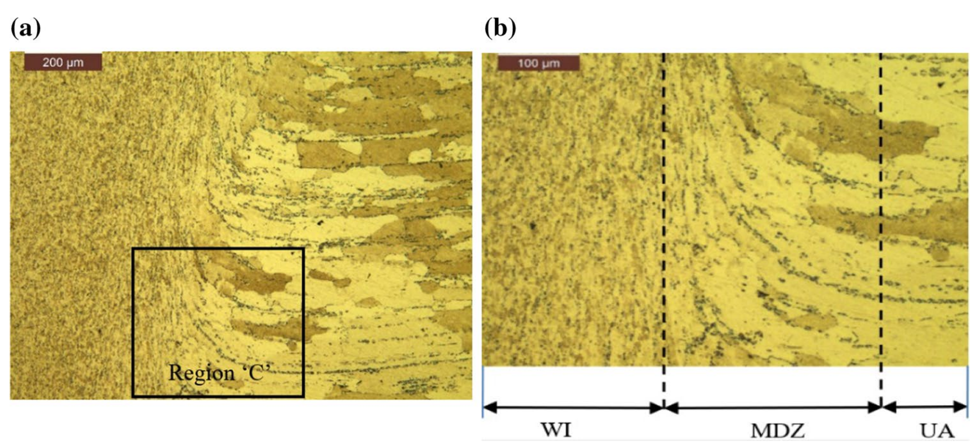

Figure 15 **a** Weld interface of optimal joint, **b** different areas near weld line

include the weld interface (WI), moderately deformed area (MDA) and the unaffected area (UA) (Fig. 15 b). The microstructures on the weld interface are characterized by the dynamic recrystallization due to higher rotational speed. The weld interface appears relatively darker compared to the other areas, as it was subjected to high temperature, stress and deformation. The grains appear dragged in the moderately deformed zone because of torque experienced by rotation at higher temperatures. More drag was found in the advancing part of the joint compared to the retreating half. The unaffected area signals the end of plastic flow and the onset of parent material away from the joint interface on both sides. Hence, the softening of material due to thermal input was more evident in the weld interface and moderately deformed zone. The remaining part of `parent material was unaffected by temperature and stress hence reducing the chances of undesirable microstructural changes and degradation of properties a possibility in fusion welded joints. The fractured surface of bond subjected to tensile loading is shown in the scanning electron microscope (SEM) images in Fig. 16a–c. Fracture was observed near the weld area as it happened in most of the experimental trials.

A gross permanent deformation (necked down) was observed near the center of the workpiece in Fig. 16a, and a closer examination reveals the microfractures and smaller voids, which appear after the specimen was stressed beyond tensile strength (Fig. 16b). The plastic deformation from the necked down area is also visible in Fig. 16c. These are primarily the features or patterns observed in ductile failure in uniaxial tension. The Vicker's hardness values were measured from the weld line towards unaffected parent material on both sides of the weld zone as per the ASTM E-18 standard with the total test force of 100 g for 10 s time. The hardness values measured at the WI, MDA and UA for the optimal joint were 204, 181 and 168 respectively. The joint obtained using initial input parameter setting (Trial No: 21) was found to possess a hardness value of WI, MDA and UA are 198, 178 and 166 respectively. Hence, it was observed that the hardness in the weld zone is relatively higher than that in the unaffected zone of parent material.

5 Conclusion

An effective attempt has been made to joint EN 10028-P355 GH steel in solid-state and possibility of forming good quality welded joints using continuous drive friction welding was also explored. The scope for simultaneous optimization of multiple responses is widened by authorizing an integrated approach of gray incidence reinforced response surface methodology for optimal parameter selection. A notorious reduction in the number of experiments was observed, as L_{27} orthogonal array was used in experimental trials unlike the

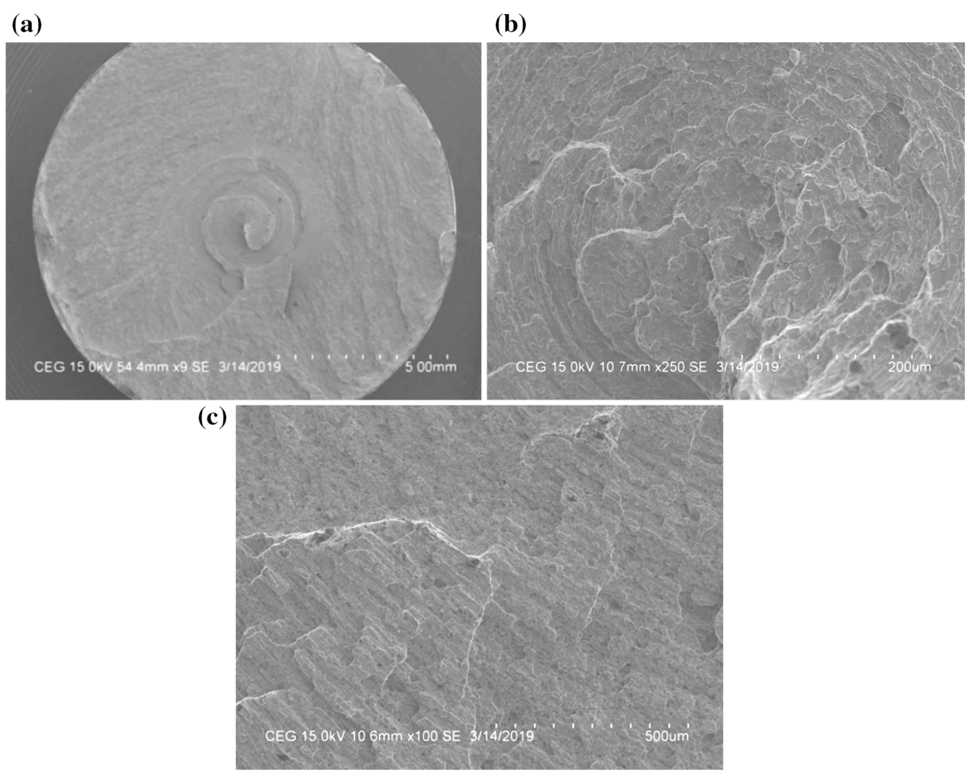

Figure 16 **a** Fractured surface, **b** voids and coalescence, **c** closer look at 'necked down' surface

conventional strategies using CCD or BBD with traditional RSM to arrive at the optimal friction welding inputs. The conclusions drawn include the following.

1. The gray incidence reinforced response surface methodology was effective in predicting the near-optimal welding condition (frictional pressure-93.94 MPa, friction time-5.22 s, upset pressure-138.14 MPa, forging time-3.58 s and rotational speed-1282.67 rpm) for joining EN 10028-P355 GH steel in a solid-state.
2. The developed quadratic model was adequate and effective in relating the various welding inputs and predicting the responses in terms of gray relational grade. The predicted and experimentally observed values were found to be reasonably closer demonstrating the model adequacy.
3. In addition to the individual welding parameters, their interactions were also observed to influence the quality characteristics of the joints. A ductile pattern was found in the fractured surface of joint.
4. The optimal welding inputs predicted by the integrated approach of gray incidence reinforced response surface methodology were found to improve the tensile strength and impact toughness. However, a less significant reduction in axial shortening could be better understood from the point of formation of a good bond with reasonably improved strength.

The findings of study could offer the sought-after guidelines for joining EN 10028-P355 GH steel in solid-state using continuous drive friction welding. The generated polynomial equations along with the experimentations will provide the necessary databank for improving the joining characteristics of material employed in boilers and pressure vessels, where the quality of joints is of utmost importance. The results could contribute in enhancing the engineering applications of the material and usage of gray incidence reinforced response surface methodology in different manufacturing strategies. The scope can be extended further to modeling the temperature at the weld interface, correlating the same with joint properties and studying the effects on ductile–brittle transition.

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Compliance with Ethical Standards

Conflict of interest The authors declare no possible conflict of interest regarding the research, authorship and publication of this article.

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Efficacy of Push-Ups on a Fitness Structure Compared to that on the Ground on Upper Body Muscular Activation in Healthy Indian Males – A Comparative Study

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ABSTRACT

Introduction: Conventional push-ups on the ground are recognized for fairly improving shoulder strength. A fitness structure has been developed for push up for improved muscle activation.

Objective: The present study aimed to compare the activity of the shoulder and trunk muscles in two push-up positions: push-ups on the fitness structure vs standard push-ups on the ground.

Methods: The study was a comparative study conducted among physically fit adult males in which 18 volunteers were recruited from physical training organization. Participants received instructions on proper push-up position and technique. Participants did 10 push-ups each and Electromyography (EMG) measures were recorded on biceps, triceps, deltoid anterior and pectoralis major muscle. These participants were asked to initially complete push-ups on the fitness structure followed by push up on the ground. The recordings of push-ups under the two conditions were analysed and compared using an unpaired t-test.

Results: The mean age of the study participants was 26.94 ± 1.259. The activity of shoulder and trunk muscles was better in the case of push-ups on the structure than on the ground. The difference in mean EMG readings of biceps muscle (11.133 ± 0.871 vs 7.346 ± 1.121) ($p<0.001$), triceps muscle (4.992 ± 0.881 vs 3.228 ± 0.438) ($p<0.001$), deltoid muscle (5.328 ± 1.373 vs 3.257 ± 1.103) ($p<0.001$) and pectoralis muscle (5.631 ± 1.290 vs 3.2906 ± 0.94875) ($p<0.001$) was statistically significant.

Conclusion: These results indicate that the designed structure could be a promising tool to those who perform rigorous physical activity. Future studies must include randomized trials to further validate our study results.

Key Words: Electromyography, Push-up exercise, Muscle activation, Upper body workout, Upper body activation, Fitness structure

INTRODUCTION

Physical fitness is a state of well-being with a low risk of premature health problems and the energy to participate in a variety of physical activities.[1] The conventional push-up is a fairly popular technique for improving muscle performance and assessing an individual's muscular endurance.[2] Push-ups are admired for being simple to learn with the involvement of very little or no equipment.[3] It is known to strengthen the upper body muscles, shoulder, arm and trunk to be precise.[2] The other advantages being rehabilitating the shoulder, stabilization training of dynamic joints, and improving proprioceptive feedback mechanisms.[4] Using Electromyographic (EMG) procedures, investigators have documented push-up as an effective method for activating muscles of the upper body.[5] However, ground push-ups are also known to place much resistance on the trunk muscles, which can place a huge load on the lumbar vertebrae causing lower back pain.[6] Changing the push-up position can affect the abdominal and vertebral muscles and lumbar angle and load.[7] Also, it's been suggested that instead of the standard push-up, using different devices for push-ups can better improve upper extremity and core muscles of the body.[8,9] It is valuable for athletes where strength training is essential, especially army professionals, bodybuilders and for many other individuals who are either recouping from any type of injury or wish to attain a certain level of fitness.[10]

A fitness structure was designed to activate different upper body muscles.[10] The fitness structure was designed to make it economical, simple to use and manufacture, and ideal for high strength training. However, the muscle activation and

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performance were not evaluated using the apparatus. Hence, the study was conducted to compare the activity of the upper body muscles in two push-up positions: push-ups on the fitness structure (experimental) vs standard push-ups on the ground (control).

MATERIALS AND METHODS

This was a comparative study conducted for a period of 2 months from June 2020- July 2020. Eighteen (18) Healthy males in the age range of 25 - 30 years who were physically fit with no upper extremity pathology within the past year were included in the study. Additionally, participants were required to engage in upper extremity resistance training including conventional push-ups at least twice a week for the past 3 months. The participants were excluded if they had upper back or upper extremity pain or if they had any recent surgeries. The study protocol was approved by the institutional ethical and review board before the commencement of the study.

Volunteers were recruited through convenience sampling technique from physical training organization till the sample of 18 was reached. Written informed consent was taken from all the participants before the commencement of the study. The participants attended two programmes separated by a minimum of 48 hours. An orientation was held to educate the participants about the purpose of the investigation. The study participants signed informed consent before the start of the study. They received instructions on proper push-up position and technique. Once assured that the subjects could correctly perform the muscle tests and exercises, the sites for electrode placement were prepared by abrading the skin with fine sandpaper and cleansing the area with 70% isopropyl alcohol. Shaving of hair was performed if necessary. Initially, the participants performed push up on the fitness structure followed by standard push-ups on the ground.

Data recording

A surface electrode was used to determine the activation of muscles. The electrodes were applied unilaterally with no preference for left or right sides. Electromyography (EMG) data were collected using a NeuroScan EMG/NCV/EP (Innotech Medical (P) Ltd., Punjab, India). All EMG signals were amplified, band-pass filtered (20–450 Hz), and sampled at 1,000 Hz. The position of placement of electrode is mentioned in Table 1 and Figure 1.

Fitness structure

The structure used in the study was an inverted U-shaped structure, 40′ long and 5′ high is grouted on a cement concrete prepared bed. This structure is supported by seven vertical supports made of the same material, again grouted on the concrete surface. Another 40′ long galvanized iron pipe is welded to this structure 2′ above the concrete surface. All joints are welded firmly on all sides. Located 2.5′ away from this axis are 24 inverted U-shaped hand supports, placed at repetitive intervals of 1.5′ -1.0′ -1.5′ from each other. These hand supports are 1.5′ long and 2′ high. They are made of steel and are 2′ ′ thick.[10] (Figures 2 and 3)

Procedure

To standardize hand and leg placement between exercises, a point was marked, where participants placed their hands and legs both on the ground and the fitness structure. While exercising the participants were asked to keep the spine straight, and shoulders flexed 90° relative to the trunk's longitudinal axis and elbows flexed 90°. The investigator placed the Electrode first on the biceps muscle (one muscle at one time). The exercise began in the "up" position with the arms extended, forearms and wrists in the neutral position. After 1st round of 10 push-ups, EMG reading on biceps muscle was recorded. Next, the patient was asked to stand up and the electrode was attached to the triceps muscle. 10 push-ups were repeated on the structure and EMG values were noted down. The same procedure was again repeated for deltoid muscle and pectoralis muscles (Figures 2 and 3).

Statistical analysis

Descriptive and inferential statistical analyses were carried out in the present study. Results on continuous measurements were presented on Mean ± SD and results on categorical measurement were presented in number (%). The level of significance was fixed at $p=0.05$ and any value less than or equal to 0.05 was considered to be statistically significant. Student t-tests (two-tailed, unpaired) was used to find the significance of study parameters on a continuous scale between two groups. The Statistical software IBM SPSS statistics 20.0 (IBM Corporation, Armonk, NY, USA) was used for the analyses of the data and Microsoft Word and Excel were used to generate graphs, tables etc. The ethical clearance was obtained from the institutional review board (no: TNPESU/R4/Ph.D./Feb-2017/08)

RESULTS

The Mean age of the study participants was 26.94 ± 1.259 years. The Mean height of the study participants was 173.11 ± 4.764 and the mean weight was 70.06 ± 7.696 (Table 2). The activity of shoulder and trunk muscles was better in the case of push-ups on the structure than on the ground. The difference in mean Electromyography readings of biceps muscle (11.133 ± 0.8714 vs 7.346 ± 1.1210) ($P<0.001$), triceps muscle (4.992 ± 0.8819 vs 3.228 ± 0.4383) ($P<0.001$), deltoid muscle (5.328 ± 1.3736 vs 3.257 ± 1.1039) ($P<0.001$) and pectoralis muscle (5.631 ± 1.2909 vs 3.290 ± 0.9487) ($P<0.001$) was statistically significant (Table 3).

DISCUSSION

The push-up exercises are very popular in upper body strengthening programs. They are closed kinetic chain exercises, for which pectoralis major and triceps brachii are the principles acting muscles.[11] Different variants of the exercise have been suggested in the past, either using different postures[12], altering the position of hands and feet[13], or compared to the movable-load bench press exercise[14], stable or unstable surfaces[15] or sling-and ground-based push-up exercise.[16] Therefore, we compared the activity of the shoulder and trunk muscles between push-ups on the fitness structure and standard push-ups on the ground.

A total of 18 volunteers participated in the study. The study findings suggested that the push-ups on fitness structure showed better activation compared to push-ups on the ground. Calatayud et al.[8] used a suspended push-up with a pulley system showed greater activation compared to standard push-ups on the floor. They suggested that suspended push helped increase core muscle activation. These findings were also comparable to the study conducted by Snarr et al.[17] which also supported this evidence. The Perfect Pushup™, a rotating handgrip device was found to be superior for activating the pectoralis major and posterior deltoid compared to conventional push-ups in the study by Allen et al.[9] and Youdas et al.[2] Sandhu et al.[18] suggested that the addition of a simple Swiss ball to your push up is capable of improving shoulder muscle activity. Kim et al.[19] suggested that the push-ups performed with the 50% palmar width resulted in greater activation of pectoralis minor, triceps brachii, and infraspinatus muscle activities. Borreani et al.[20] suggested that any unstable surface such as wobble board, stability disc, fitness dome, and Suspension Trainer improves muscle activation. All these studies showed that modification of conventional push-up technique may yield positive results in terms of better muscle activation.

The study results showed that fitness structure is a decent alternative for ground push-ups providing better muscular activation. The structure used is cost-effective. However, we did not conduct an in-depth analysis of the push-ups on the patients. The other limitations were that the convenience sampling technique was employed for the study which does not truly represent the general population. This study was a simple comparative study with a limited sample size; thus, the observed association cannot be interpreted as causal inferences. However, this was the first study that contributed significantly to the literature by introducing a new apparatus in fitness training. In future, it's recommended to conduct a multicentric large scale randomized trial on a wider population (including females, different ethnicity, people from different geographical location etc.) to further validate the study results.

CONCLUSION

The study results showed that fitness structure is a cost-effective and good alternative for ground push-ups providing better muscular activation. This study was one of the very first studies that developed and studied the modified push-ups on an apparatus. This apparatus could be deemed useful in already fit individuals like army personal, bodybuilders and many other fitness enthusiasts.

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Authors contributions:

1. Vikas Malik: concept, design, literature search, data acquisition, the definition of intellectual content, manuscript editing and manuscript review.
2. Dr. R. Ramakrishnan: concept, data analysis, statistical analysis, the definition of intellectual content, manuscript editing and manuscript review.

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Table 1: Position of electrode placement

S no	Muscle name	Position of EMG electrode	Muscle activation
1	Biceps brachii	Placed in the middle of the forearm just anterior to the radius.	Flexing the distal phalanx of the thumb activates the muscle
2	Triceps	Placed posterior to deltoid tubercle, for long head 6-8 cm (4 fingerbreadths) distal to the posterior axillary fold	Activated during push up on fitness structure
3	Deltoid Anterior	Placed 4-5 cm below the anterior margin of the acromion	Activated by forwarding elevation of the arm
4	Pectoralis Major	Placed on the anterior axillary fold	Measured during exercise

Table 2: Descriptive statistics (N=18)

Variable	Mean	Standard Deviation
Age	26.94	1.259
Height	173.11	4.764
Weight	70.06	7.696

Table 3: Comparison of the Electromyography readings of push-ups on structure and on ground using unpaired t-test (N=18)

Muscles	Structure	Ground	t value	P-value
Biceps	11.133 ± 0.8714	7.346 ± 1.1210	11.316	<0.001**
Triceps	4.992 ± 0.8819	3.228 ± 0.4383	7.601	<0.001**
Deltoid	5.328 ± 1.3736	3.257 ± 1.1039	4.986	<0.001**
Pectoralis	5.631 ± 1.2909	3.290 ± 0.9487	6.198	<0.001**

Figure 1: Position of electrode placement.

Figure 2: Push-up on structure.

Figure 3: Push-up on the ground.

IMPACT OF RESISTANCE AND COMPLEX TRAINING ON SPEED AND AGILITY AMONG WOMEN KABADDI PLAYERS

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ABSTRACT

The purpose of the study was to find out the impact of resistance and complex training on speed and agility among women kabaddi players. To achieve the purpose of the study, forty five women kabaddi players were selected from Queen Mary's College Chennai. The subject's age ranged between 18-23 years. The selected subjects were divided into three equal groups of fifteen each. Group – I (n = 15) underwent Resistance Training (RT), Group – II (n = 15) underwent Complex Training (CT) and Group– III (n = 15) acted as control. The collected data from the three groups prior to and post experimentation on speed and agility were statistically analyzed to find out the significant difference if any, by applying the analysis of covariance (ANCOVA). Since three groups were involved, whenever the obtained 'F' ratio value was found to be significant for adjusted post test means, the Scheffe's test was applied as post hoc test to determine the paired mean differences, if any. The result of the study revealed that twelve weeks of resistance and complex training had an impact to increase on speed and agility of women kabaddi players. It was concluded that from the results of the study both resistance and complex training is essential for the improvement of the speed and agility of women kabaddi players.

Key words: Resistance, complex training, speed and agility.

INTRODUCTION

Resistance training increases muscle strength by pitting muscles against a weight, such as a dumbbell, barbell or other type of resistance. A rubberized band can even be used. Resistance training can increase muscle strength and bone density and reduce body fat. Resistance training, also called weight training or strength training, is pitting muscles against a resistance such as a weight or other type of resistance, to build the strength, anaerobic endurance, and/or size of skeletal muscles. A well-rounded program of physical activity includes strength training, to improve bone, joint function, bone density, muscle, tendon and ligament strength, as well as aerobic exercise, to improve our heart and lung fitness. The body's basal metabolic rate increases with increases in muscle mass, which promotes long-term fat loss and helps dieters avoid yo-yo dieting. Moreover, intense workouts elevate metabolism for several hours following the workout, which also promotes fat loss (De Mello and Gomes, 2004).

Complex training also known as contrast training or post-activation potentiation training, involves the integration of strength training and plyometrics in a training system designed to improve explosive power. Strength training and plyometric training are both effective measures for increasing athletic performance independent of each other, but a true program designed for power-based athletes needs to incorporate both disciplines. The goal of this type of training is to acutely or over long-term training enhance power output in tasks such as jumping, sprinting, and throwing a ball (Fleck and Kraemer, 2013).

Kabaddi is the team game where seven players in the court will play as a unit. Kabaddi is basically an outdoor team game, played in the tropical countries of Asia.

METHODOLOGY

Subjects and Variables

The purpose of the study was to find out the impact of resistance and complex training on speed and agility among women kabaddi players. To achieve the purpose of the study, forty five women kabaddi players were selected from Queen Mary's College Chennai. The subject's age ranged between 18-23 years. The selected subjects were divided into three equal groups of fifteen each. Group – I (n = 15) underwent Resistance Training (RT), Group – II (n = 15) underwent Complex Training (CT) and Group– III (n = 15) acted as control. The speed was measured through 50 meters sprint test, agility was measured by T-test.

Training Protocol

Group I underwent resistance for three days per week for twelve weeks with 2-4 sets: 8-10 repetitions, and group II underwent complex training for three days per week for twelve weeks with 2-4 sets: 8-10 repetitions along with 2 min rest. In every day training session, the work out lasted approximately between 45 minutes, which included warming up and limbering down.

Experimental Design and Statistical Technique

The experimental design in this study was random group design involving 45subjects. The collected data from the three groups prior to and post experimentation on speed and agility were statistically analyzed to find out the significant difference if any, by applying the analysis of covariance (ANCOVA). Since three groups were involved, whenever the obtained 'F' ratio value was found to be significant for adjusted post test means, the Scheffe's test was applied as post hoc test to determine the paired mean differences, if any.

Results

The data collected before and after the experimental period on speed of experimental and control group were analysed and presented in table – I.

Table - I

Analysis of Covariance on Speed of Resistance and Complex Training and Control Groups

	Resistance Training	**Complex Training**	**Control Group**	**SOV**	**Sum of Squares**	**df**	**Mean squares**	**'F' ratio**
Pre test Mean SD	7.95	7.88	7.85	B	0.080	2	0.040	0.28
	0.35	0.36	0.41	W	5.99	42	0.14	
Post test Mean SD	7.34	7.05	7.78	B	3.52	2	1.76	24.24*
	0.27	0.15	0.34	W	3.05	42	0.07	
Adjusted Post test Mean	7.32	7.07	7.79	B	3.57	2	1.78	24.87*
				W	2.94	41	0.07	

**Significant at .05 level of confidence (The required table value for significance at 0.05 level of confidence with degree of freedom 2 and 42 is 3.22 and degrees of freedom 2 and 41 is 3.23)*

Table shows that the pre test means and standard deviation (SD) on speed of resistance and complex training and control groups are 7.95 $\pm$ 0.35, 7.88 $\pm$ 0.36 and 7.85 $\pm$ 0.41 in that order. The attained 'F' ratio assessment of 0.28 was not as much of the essential table score of 3.22 for the quantity of freedom 2 and 42 at 0.05 level of pledge, which shows that the informal mission of the subjects were a success because the pre check scores on speed among groups didn't vary drastically.

The post take means and SD on speed of resistance and complex training and control groups are 7.34 $\pm$ 0.27, 7.05 $\pm$ 0.15 and 7.78 $\pm$ 0.34 in that order. The attained 'F' ratio assessment of 24.24 on speed was as much of the essential table score of 3.22 for the quantity of freedom 2 and 42 at 0.05 level of pledge. It implies that important variation existed between the groups on the post test phase on speed.

The adjusted post-test means on speed of resistance and complex training and control groups are 7.32, 7.07 and 7.79 respectively. The attained ‘F’ ratio assessment is 24.87 of speed was as much of the essential table score of 3.23 for the quantity of freedom 2 and 41 at 0.05 level of assurance. The outcome of the study tells that, major differences be presented among experimental and control groups on speed.

Since, the adjusted post test mean ‘F’ value was found to be considerable, the data on speed is subjected to post hoc analysis using Scheffe’S test and the results are offered in table–II.

Table – II
Scheffe’S Test for the Differences between the Adjusted Post Test Paired Means on Speed

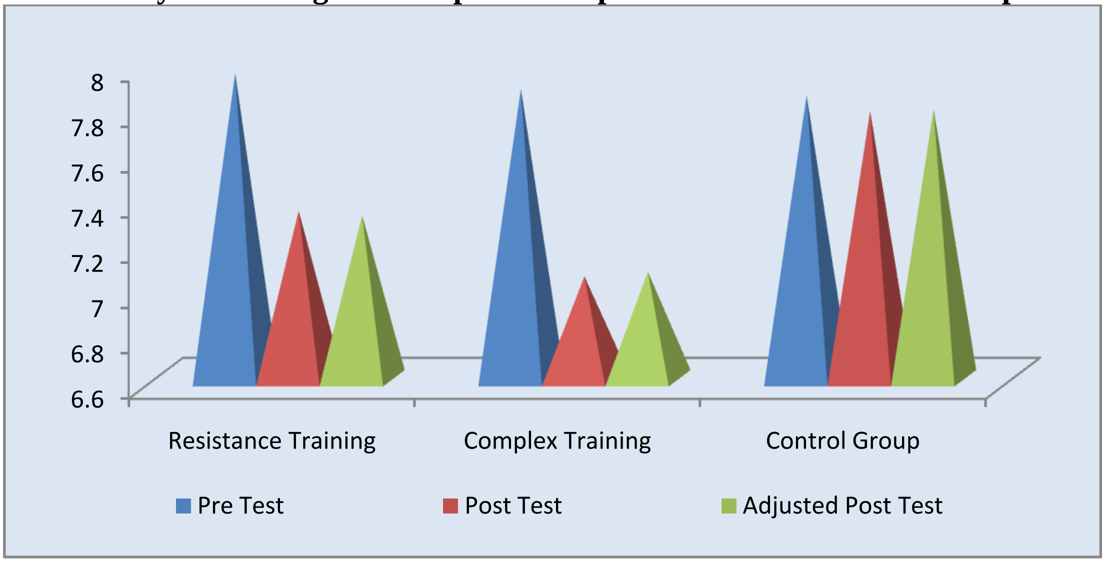
Adjusted Post Test Mean			Mean Differences	Confidence Interval
Resistance Training	Complex Training	Control Group		
7.32	7.07		0.25*	0.24
7.32		7.79	0.47*	0.24
	7.07	7.79	0.72*	0.24

**Significant at .05 level.*

Table–II shows that the adjusted post test mean differences on speed between resistance and complex training groups; resistance and control groups; complex training and control groups. The result indicates that there were significant difference among the experimental and control groups on speed of the women kabaddi players. Hence, complex training had better stimulation to increase on speed of women kabaddi players.

Figure -1

Pyramid Diagram on Speed of Experimental and Control Groups



The data collected before and after the experimental period on agility of experimental and control group were analysed and presented in table – III.

Resistance & Complex Training and Control Groups

Analysed by ANCOVA on Agility

	Resistance Training	Complex Training	Control Group	SOV	Sum of Squares	df	Mean squares	'F' ratio
Pre test Mean	10.18	10.11	10.23	B	0.10	2	0.05	0.40
SD	0.44	0.27	0.30	W	5.18	42	0.12	
Post test Mean	9.34	9.00	10.22	B	12.03	2	6.01	53.05*
SD	0.34	0.31	0.34	W	4.76	42	0.11	
Adjusted Post test Mean	9.33	9.04	10.19	B	10.57	2	5.28	78.78*
				W	2.75	41	0.06	

**Significant at .05 level of confidence (The required table value at 0.05 level of confidence with df 2 and 42 is 3.22 and df 2 and 41 is 3.23)*

Table–3 shows that the pre test means and standard deviation (SD) on agility of resistance & complex training and control groups are 10.18 ± 0.44, 10.11 ± 0.27 and 10.23 ± 0.30 in that order. The attained 'F' ratio assessment of 0.40 was not as much of the essential table score of 3.22 for the quantity of freedom 2 and 42 at 0.05 level of pledge, which shows that the informal mission of the subjects were a success because the pre check scores on agility among groups didn't vary drastically.

The post-take means and SD on agility of resistance & complex training and control groups are 9.34 ± 0.34, 9.00 ± 0.31 and 10.22 ± 0.34 in that order. The attained 'F' ratio assessment of 53.05 on agility was as much of the essential table score of 3.22 for the quantity of freedom 2 and 42 at 0.05 level of pledge. It implies that important variation existed between the groups on the post test phase on agility.

The adjusted post-test means on agility of resistance & complex training and control groups are 9.33, 9.04 and 10.19 respectively. The attained 'F' ratio assessment is 78.78 of agility was as much of the essential table score of 3.23 for the quantity of freedom 2 and 41 at 0.05 level of assurance. The outcome of the study tells that, major differences be presented among experimental and control groups on agility. Since, the adjusted post test mean 'F' value was found to be considerable, the data on agility is subjected to post hoc analysis using Scheffe'S test and the results are offered in table–4.

Table – 4

Scheffe's Test on Agility

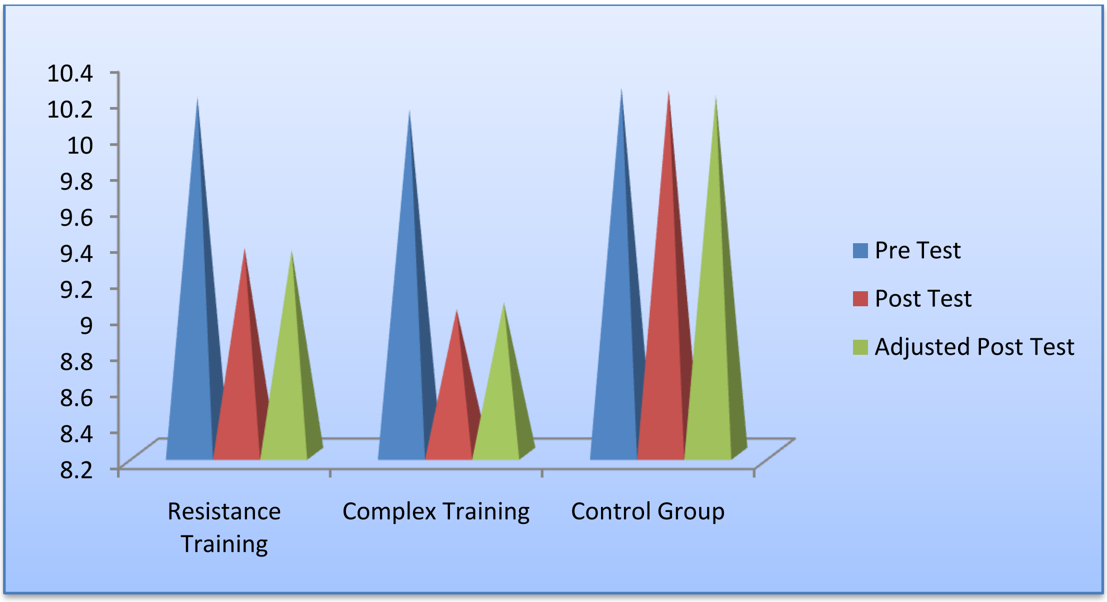
Adjusted Post Test Mean			Mean Differences	Confidence Interval
Resistance Training	Complex Training	Control Group		
9.33	9.04		0.29*	0.22
9.33		10.19	0.86*	0.22
	9.04	10.19	1.15*	0.22

**Significant at .05 level.*

Table–4 shows that the adjusted post test mean differences on agility between resistance and complex training groups; resistance training and control groups; complex training and control groups. The result indicates that there were significant difference among the experimental and control groups on agility of the women kabaddi players. Hence, complex training had well increase on agility of women kabaddi players.

Figure -2

Pyramid Diagram on Agility



Discussion on Findings

Speed

The result of the study inform that twelve weeks of resistance, complex training induced to increase on speed of women kabaddi players when compared to the control group players. Hence, complex training had better stimulation to increase on speed of women kabaddi players. The following studies are strengthening the present results. Corn and Knudson (2003) found that towing with an elastic cord during the acceleration phase resulted in significant differences in running speed, stride length and touchdown distance of the contact foot between the free sprint and the assisted sprint. Hence it is suggested that for long-lasting change, there needs to be a systematic administration of a sufficient stimulus, followed by an adaptation of the individual, and then the introduction of a new, progressively greater stimulus.

Resistance during sprinting has been proposed to increase force output in the lower extremity, increase stride length, and increase explosiveness during initial strides (Costello, 1985). The group that used complex training resistance and plyometric (combined methods) was the only group that showed significant increases in both strength and power (Fatouros and others, 2000). Muthuraj (2016) investigate the effect of interval training on speed of college men. The result of the study proved that due to the effect of interval training the speed significantly improved for college men.

Agility

The result of the study informed that twelve weeks of resistance and complex training induced to increase on agility of the women kabaddi players, when compared to control group women kabaddi players. Among experimental training groups complex training had well increase on agility of women kabaddi players. The following studies are supporting the current result. Sathees and Simson (2017) conducted study is to evaluate the effectiveness of a complex training program on skill related physical fitness in hockey players. The complex training program intervention for 6 weeks improved their skill related physical fitness of the hockey players. Jeffrey and Haris (2020) conduct the effect of Complex training on vertical jump (VJ) performance. Complex training can serve as alternative training from RT in improving VJ performance. Diyar (2018) examined short-term effects of complex training program on the sprint and vertical jump ability of soccer player**.** There were changed the result meaningful had reaction speed time and height in the vertical jump in the subjects In pre-test and post-test. Lesinski and others (2014) conducted Effects of complex training on strength and speed performance in athletes. Complex training represents an effective training regimen for athletes if the goal is to enhance strength, power, and speed.

Conclusions

The conclusion of the study inform that twelve weeks of resistance, complex training induced to increase on speed and agility of women kabaddi players when compared to the control group players.

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IMPACT OF RESISTANCE AND COMPLEX TRAINING ON ANAEROBIC POWER AND LUNG CAPACITY AMONG WOMEN KABADDI PLAYERS

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ABSTRACT

The purpose of the study was to find out the impact of resistance and complex training on anaerobic power and lung capacity among women kabaddi players. To achieve the purpose of the study, forty five women kabaddi players were selected from Queen Mary's College Chennai. The subject's age ranged between 18-23 years. The selected subjects were divided into three equal groups of fifteen each. Experimental Group – I (n = 15) underwent Resistance Training (RT), Experimental Group – II (n = 15) underwent Complex Training (CT) and Group– III (n = 15) acted as control. The collected data from the three groups prior and post experimentation on anaerobic power and lung capacity were statistically analyzed to find out the significant difference if any, by applying the analysis of covariance (ANCOVA). Since three groups were involved, whenever the obtained 'F' ratio value was found to be significant for adjusted post test means, the Scheffe's test was applied as post hoc test to determine the paired mean differences, if any. The result of the study revealed that twelve weeks of resistance and complex training had a significant impact in terms of improvement on anaerobic power and lung capacity of women kabaddi players. It was concluded that from the results of the study both resistance and complex training is essential for the development of functional ability of cardiorespiratory and muscular system. Further, it improves the anaerobic power and lung capacity of women kabaddi players.

Key words: Resistance, complex training, anaerobic power and lung capacity.

INTRODUCTION

Regular resistance training or Strength training has become established as a key component of physical preparation for the majority of sports. For the majority of sports it is suggested that athletes require optimal levels of strength as opposed to maximal levels of strength in order to successfully compete in their sport (Murray and Brown, 2006). It is therefore important to recognize that 'optimal strength' may be a more important training goal than maximal strength.

A resistance training program can affect almost every system in the body and is used in a wide variety of populations. The benefits of resistance training are numerous and include increases in strength, muscle mass, and bone density. Common program goals in resistance training are related to improvements in function, such as increased muscular strength, power, and local muscular endurance, or decreased body fat. Other functional gains such as increased coordination, agility, balance, and speed are also commongoals of a program. Other goals may relate to physiological changes related to increased body mass through muscle hypertrophy, improved blood pressure, decreased body fat, and increased metabolic rate for caloric expenditure (Barbara Bushman and Rebecca Battista (2014).

Regular resistance training offers many benefits; here some of the benefits are brought for the related to the study. Strength training increases bone density and reduces the risk of osteoporosis. It help us to control our body weight at the same time we can gain the muscles power, when gaining muscles power our body muscles efficiently burns more calories. Strength training builds the muscles it protects the body joints from injury. Strength training boosts our stamina when we grow stronger and we won't fatigue as easily. It helps us to maintain our flexibility and balance and helps us remain independent as in our aged stage. It can also boost our self-confidence, improve the body image and reduce the risk of depression. People who regularly take part in strength training they will get better night's sleep. It can reduce the sign and symptoms of many chronic conditions including arthritis, back pain, depression, diabetes and obesity.

The combination of traditional weightlifting movements followed by plyometric movements is termed complex training. Complex training is considered a very effective training program for developing power, since it alternates high load weightlifting movements with biomechanically similar plyometric movements in the same workout. The theory of complex training is that the stimulus for the plyometric movements will be higher when a resistance movement is performed prior because of the heightened motor neuron excitability brought on by the weight lifted (May, Cipriani and Lorenz, 2010). Kabaddi is the team game where seven players in the court will play as a unit. Kabaddi is basically an outdoor team game, played in the tropical countries of Asia.

METHODOLOGY

Subjects and Variables

The purpose of the study was to find out the impact of resistance and complex training on anaerobic power and lung capacity among women kabaddi players. To achieve the purpose of the study, forty five women kabaddi players were selected from Queen Mary's College Chennai. The subject's age ranged between 18-23 years. The selected subjects were divided into three equal groups of fifteen each. Group – I (n = 15) underwent Resistance Training (RT), Group – II (n = 15) underwent Complex Training (CT) and Group– III (n = 15) acted as control. The anaerobic power was measured by Margaria Kalamen Power test. Lung capacity was measured by wet-spirometer.

Training Protocol

Group I underwent resistance for three days per week for twelve weeks with 2-4 sets: 8-10 repetitions, and group II underwent complex training for three days per week for twelve weeks with 2-4 sets: 8-10 repetitions along with 2 min rest. In every day training session, the work out lasted approximately between 45 minutes, which included warming up and limbering down.

Experimental Design and Statistical Technique

The experimental design in this study was random group design involving 45subjects. The collected data from the three groups prior to and post experimentation on anaerobic power and lung capacity were statistically analyzed to find out the significant difference if any, by applying the analysis of covariance (ANCOVA). Since three groups were involved, whenever the obtained 'F' ratio value was found to be significant for adjusted post test means, the Scheffe's test was applied as post hoc test to determine the paired mean differences, if any.

Results

The data collected before and after the experimental period on anaerobic power of experimental and control group were analysed and presented in table – I.

Table - I

Analysis of Covariance on Anaerobic Power of Resistance and Complex Training and Control Groups

	Resistance Training	Complex Training	Control Group	SOV	Sum of Squares	df	Mean squares	'F' ratio
Pre test Mean SD	229.20	230.06	229.73	B	5.73	2	2.86	0.22
	4.05	2.52	3.89	W	532.26	42	12.68	
Post test Mean SD	259.20	279.13	231.46	B	17192.93	2	8596.46	358.23*
	5.45	4.37	4.80	W	1007.86	42	23.99	
Adjusted Post test Mean	259.34	279.01	231.44	B	17120.72	2	8560.36	367.36*
				W	955.38	41	23.30	

**Significant at .05 level of confidence (The required table value for significance at 0.05 level of confidence with degree of freedom 2 and 42 is 3.22 and degrees of freedom 2 and 41 is 3.23)*

Table shows that the pre test means and standard deviation (SD) on anaerobic power of resistance and complex training and control groups are 229.20 $\pm$ 4.05, 230.06 $\pm$ 2.52 and 228.73 $\pm$ 0.89 in that order. The attained ‘F’ ratio assessment of 0.22 was not as much of the essential table score of 3.22 for the quantity of freedom 2 and 42 at 0.05 level of pledge, which shows that the informal mission of the subjects were a success because the pre check scores on anaerobic power among groups didn’t vary drastically.

The post take means and SD on anaerobic power of resistance and complex training and control groups are 259.20 $\pm$ 5.45, 279.13 $\pm$ 4.37 and 231.46 $\pm$ 4.80 in that order. The attained ‘F’ ratio assessment of 358.23 on anaerobic power was as much of the essential table score of 3.22 for the quantity of freedom 2 and 42 at 0.05 level of pledge. It implies that important variation existed between the groups on the post test phase on anaerobic power.

The adjusted post-test means on anaerobic power of resistance and complex training and control groups are 259.34, 279.01 and 231.44 respectively. The attained ‘F’ ratio assessment is 367.36 of anaerobic power was as much of the essential table score of 3.23 for the quantity of freedom 2 and 41 at 0.05 level of assurance. The outcome of the study tells that, major differences be presented among experimental and control groups on anaerobic power.

Since, the adjusted post test mean ‘F’ value was found to be considerable, the data on speed is subjected to post hoc analysis using Scheffe’S test and the results are offered in table–II.

Table – II

Scheffe'S Test for the Differences between the Adjusted Post Test Paired Means on Anaerobic Power

Adjusted Post Test Mean			Mean Differences	Confidence Interval
Resistance Training	Complex Training	Control Group		
259.34	279.01		19.67*	4.47
259.34		231.44	27.90*	4.47
	279.01	231.44	47.57*	4.47

**Significant at .05 level.*

Table–II shows that the adjusted post test mean differences on anaerobic power between resistance and complex training groups; resistance and control groups; complex training and control groups. The result indicates that there were significant difference among the experimental and control groups on anaerobic power of the women kabaddi players. Hence, complex training had better stimulation to increase on anaerobic power of women kabaddi players.

Figure -1

PYRAMID DIAGRAM ON ANAEROBIC POWER OF EXPERIMENTAL AND CONTROL GROUPS

The data collected before and after the experimental period on lung capacity of experimental and control group were analysed and presented in table – 3.

Table - 3

Resistance & Complex Training and Control Groups Analysed by ANCOVA on Lung Capacity

	Resistance Training	**Complex Training**	**Control Group**	**SOV**	**Sum of Squares**	**df**	**Mean squares**	**'F' ratio**
Pre test Mean SD	2.80	2.85	2.85	B	0.011	2	0.006	0.21
	0.14	0.18	0.16	W	1.09	42	0.026	
Post test Mean SD	3.02	3.15	2.86	B	0.64	2	0.32	12.85*
	0.14	0.17	0.15	W	1.05	42	0.02	
Adjusted Post test Mean	3.03	3.14	2.85	B	0.660	2	0.330	31.82*
				W	0.425	41	0.010	

**Significant at .05 level of confidence (The required table value at 0.05 level of confidence with df 2 and 42 is 3.22 and df 2 and 41 is 3.23)*

Table–3 shows that the pre test means and standard deviation (SD) on vital capacity of resistance & complex training and control groups are 2.80 $\pm$ 0.14, 2.85 $\pm$ 0.18 and 2.85 $\pm$ 0.16 in that order. The attained 'F' ratio assessment of 0.21 was not as much of the essential table score of 3.22 for the quantity of freedom 2 and 42 at 0.05 level of pledge, which shows that the informal mission of the subjects were a success because the pre check scores on vital capacity among groups didn't vary drastically.

The post-take means and SD on vital capacity of resistance & complex training and control groups are 3.02 $\pm$ 0.14, 3.15 $\pm$ 0.17 and 2.86 $\pm$ 0.15 in that order. The attained 'F' ratio assessment of 12.85 on vital capacity was as much of the essential table score of 3.22

for the quantity of freedom 2 and 42 at 0.05 level of pledge. It implies that important variation existed between the groups on the post test phase on vital capacity.

The adjusted post-test means on vital capacity of resistance & complex training and control groups are 3.03, 3.14 and 2.85 respectively. The attained 'F' ratio assessment is 31.82 of vital capacity was as much of the essential table score of 3.23 for the quantity of freedom 2 and 41 at 0.05 level of assurance. The outcome of the study tells that, major differences be presented among experimental and control groups on vital capacity.

Since, the adjusted post test mean 'F' value was found to be considerable, the data on vital capacity is subjected to post hoc analysis using Scheffe'S test and the results are offered in table–4.

Table – 4

Scheffe'S Test on Lung Capacity

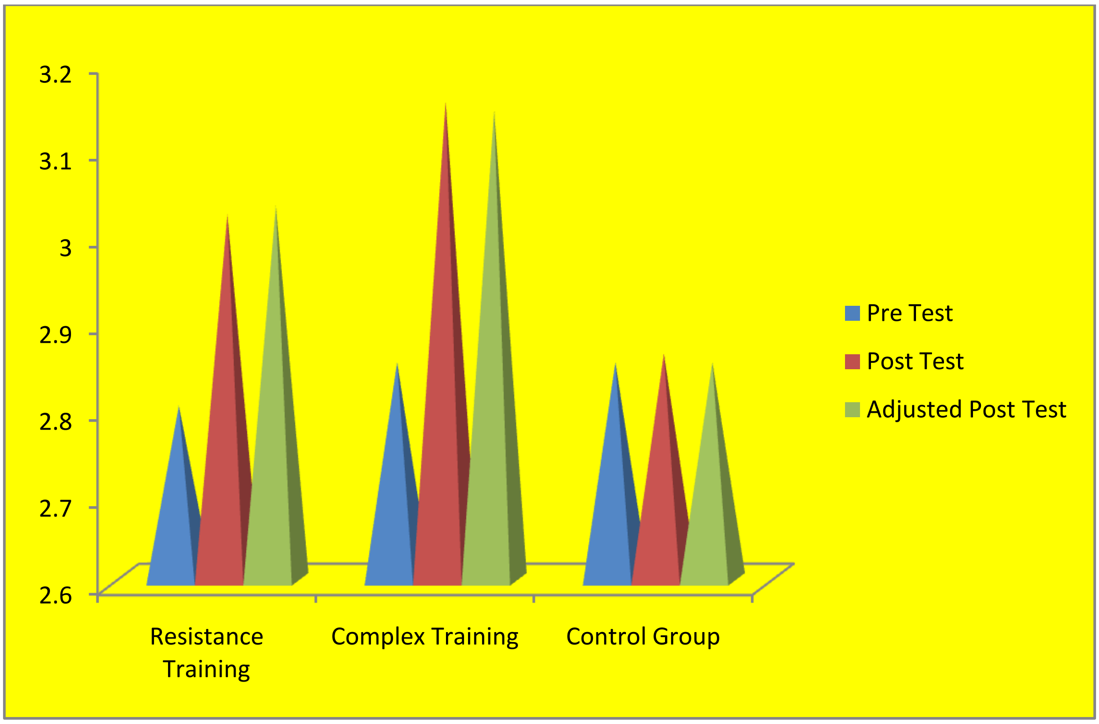
Adjusted Post Test Mean			Mean Differences	Confidence Interval
Resistance Training	Complex Training	Control Group		
3.03	3.14		0.11*	0.09
3.03		2.85	0.18*	0.09
	3.14	2.85	0.29*	0.09

**Significant at .05 level.*

Table–4 shows that the adjusted post test mean differences on vital capacity between resistance and complex training groups; resistance training and control groups; complex training and control groups. The result indicates that there were significant difference among the experimental and control groups on vital capacity of the women kabaddi players. Hence, complex training had well increase on lung capacity of women kabaddi players.

Figure -2

PYRAMID DIAGRAM ON LUNG CAPACITY



Discussion on Findings

Anaerobic Power

The result of the study inform that twelve weeks of resistance, complex training induced to increase on anaerobic power of women kabaddi players when compared to the control group players. Hence, complex training had better stimulation to increase on anaerobic power of women kabaddi players. The following studies are strengthening the present results. Rumpf and others (2016), examined the effect of different sprint training methods on sprint performance over various distances. The implementation of nonspecific training methods (e.g., strength and power training) could also benefit speed and athletic performance. Wong and others (2010) found that combined strength and power training significantly improved vertical jump height of young soccer players. Hawkins and others (2009) results did indicate that high-velocity and high-force training programs, consisting of weightlifting and plyometrics, improved lower-body performance, especially in the areas of jump height and power. Gomez-Perez and others

(2008), who studied the effects of a training program consisting of weight lifting combined with plyometric exercises on kicking performance was examined in 37 male physical education students, the result found that enhanced performance in vertical jump**.** Fatouros and others (2000) compared the effects of 3 different training protocols plyometric training, weight training and their combination selected parameters of vertical jump performance and leg strength. This study provides support for the use of a combination of plyometric drills and weight training to improve vertical jumping ability and muscular power in general. Ganesan and Muthuraj (2020) conducted a study on effect of weighted vest and weighted sled running on anaerobic power of sprinters. The result of the study stated that twelve weeks of weighted vest and weighted sled running induced to increase an anaerobic power of male school sprinters. Mihri and others (2016) examined the effects of plyometric training on anaerobic power capacity and motor skills in female fustal players. The results of the study showed that plyometric training significantly increased anaerobic capacity. Abdul, *et al*., (2014) investigated the effect of 8 weeks of strength and plyometric training on anaerobic power, explosive power and strength quadriceps femurs muscle in Soccer Players. The results of the study showed that plyometric training improves anaerobic power in soccer players.

Lung Capacity

The result of the study informed that twelve weeks of resistance and complex training induced to increase on lung capacity of the women kabaddi players, when compared to control group women kabaddi players. Among experimental training groups complex training had well increase on vital capacity of women kabaddi players. The following studies are supporting the current result. Kanniyan, & Ibrahim., (2013) find out effect of complex and contrast training on selected physiological and bio-motor variables of men soccer players. The results of the study indicate that there are significant differences among complex training group and contrast training group and the control group in all of the physiological and bio-motor variables selected for the study. Muthuraj and Wise (2011) determined the effect of concurrent strength and endurance training and detraining on vital capacity. The concurrent strength and endurance training improved vital capacity (5.91%) all training induced gains had been abolished after thirty days of detraining.

Conclusions

The conclusion of the study inform that twelve weeks of resistance, complex training induced to increase on anaerobic power and lung capacity of women kabaddi players when compared to the control group players..

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EFFICACY OF SAQ TRAINING ON EXPLOSIVE POWER AND AGILITY AMONG JUNIOR BADMINTON PLAYERS

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Abstract

Background and Aim: Badminton is a team sport that contains varied activities and various technical skills that a player must perform during the game. Badminton player required to perform combinations of speed, agility and jumping abilities to achieve the best performance. SAQ training is known as one of the most effective training methods to improve performance in team sports.

Materials and Methods: To achieve the purpose of the study, twenty (N=20) junior badminton players were randomly selected and their age ranged between 11 and 15 years.The subjects chosen for the study were divided into two equal groups and designated as one experimental groups and one control group each consisted of ten junior badminton players. The experimental group underwent SAQ training and control group were not having any special training programme. The SAQ training was applied for only 12 weeks training for 3 days per week one session 45- 90 minutes programme. The data were collected from explosive power was tested by using Vertical Jump and agility was tested by using `T-Test prior and after the application of experimental training.

Results: The results revealed that SAQ training produce significant improvement on explosive power and agility among junior badminton players. The differences were found to be significant at 0.05 level. Thus, it was proved that SAQ training is the best training intervention for junior badminton players to enhance overall playing ability.

Conclusion: Based on the result of the study it is concluded that the 12 weeks SAQ training have been significantly improved explosive power and agility among junior badminton players. From the finding it is suggested that Speed, Agility and Quickness (SAQ) methods of training is suitable mode to bring out desirable change over explosive power and agility among junior badminton players.

Key Words: SAQ Training, Explosive Power and Agility

Introduction

Speed, Agility and Quickness (SAQ) training allows players to enhance their ability to accelerate, decelerate, and dynamically stabilize their entire body during higher-velocity acceleration and deceleration movements in all planes of motion (Brown, Ferrigno and Santana, 2000). The term speed is simply refers to the speed or velocity of distance covered divided by time. Agility refers to short bursts of movement that involve a change of movement direction, cadence, or speed. Quickness refers to the ability to react to a stimulus and appropriately change the motion of the body. “Speed, agility and quickness are a system of training aimed at the development of motor abilities and the control of body movement through the development of the neuromuscular system" (Lennemann et al., 2013; Yap and Brown, 2000).

"The Game of Badminton is wonderful sport that requires eye-hand coordination, striking and quick movements and change of direction in pursuit of the shuttle cock. Badminton is a power game requiring quick and powerful movements to all directions to return the shuttle cock to the opponents' side of the court". Badminton is a highly explosive sport, involving aunique movement technique over a relatively small court area (Hughes,1995).Speed, agility and quickness training has become a popular way to train players.Speed, agility and quickness training may be used to increase speed or strength, or the ability to exert maximal force during high-speed movements. Speed, agility and quickness training can cover the complete spectrum of training intensity, from low to high intensity. Every individual will come into a training program at a different level; thus training intensities must coincide with the individual's abilities.

Badminton is a net game with a net diving players' territory. While players constantly use directional shots to outscore opponents, they must also return the opponent's shots by running rapidly and repeatedly on court with change of direction to intercept the shuttlecock. Given the short shuttlecock flight time in a rally (Manrique& Gonzalez-Badillo, 2003; Chen, Pan & Chen, 2009), the player typically has less than one second to react and run to complete the interception. Therefore, badminton demands on-court agility that includes both physical and perceptual quickness, and having the ability to anticipate the shot will greatly ease the challenge to improve the on-court agility (Abernethy et al., 2012).A racquet sport player would need to develop higher levels of the basic physical qualities to be able to compete effectively against stronger opponents (Groppel and Roetert, 1992).

Agility can be understood as the skills and abilities needed to achieve explosive changes in movement direction, velocities or techniques in response to one or more stimuli (Sheppard, and Young, 2006).Quick, controlled changes in direction are needed for successful performance in individual activities as well as in team sports (Lacy, &Hastad, 2014). Power is the ability to exert a maximum amount of force in a minimum amount of time. It is often described in terms of explosive types of movements, such as the vertical jump. Power requires both strength and speed and therefore typically is greater in those with greater muscle mass. Muscular power or explosive strength is one such element, and the ability to generate great amounts of power is recognized as a primary factor in athletic success (Beckenholdt and Mayhew, 1983). According to Omosegaard (1996), an explosive player will typically be able to jump high, change direction quickly and will generally appear to be swift and mobile on the badminton court.

Badminton player must possess the necessary joint range of motion; inter muscular coordination and strength qualities throughout their lower limb kinetic chain in order to properly execute change of direction movements. In most sports, a player must be able to accelerate, decelerate and change directions rapidly with good body control in order to perform well and reduce their risk of injury. Therefore, the purpose of this study was to examine the effectiveness of using SAQ training on explosive power and agility among junior badminton players.

Materials and Methods

To achieve the purpose of the study, twenty (N=20) junior level badminton players were randomly selected from Chennai city and their age ranged between 11 and 15 years. The selected participants were divided into two groups which were experimental and control group. The experimental group underwent SAQ training for 12 weeks with three days per week. In which, the control group did not participate in SAQ training program. The data were collected from prior and immediately after training program on explosive power and agility. The dependent variable of explosive power was tested by using Vertical Jump and agility was tested by using `T-Test. The data was analysed by applying Analysis of Covariance (ANCOVA) Technique to find out the effect of SAQ Training on explosive power and agility of junior level badminton players. The level of significance was set at 0.05. **Exercise Program:** The SAQ training program was performed 3 days/ week for 12 weeks. The SAQ training session lasted for 45 to 60 minutes, which included 10 minutes warm-up. Based on the principles of sports training, the intensity of training was gradually increased every three weeks. During the first three weeks, subjects performed 3-sets, 6-repetition, Work rest ratio: 1:3, with the intensity of 60 to 65%; in weeks 4 and 6: 3-sets, 8-repetition, Work rest ratio: 1:3, with the intensity of 65 to 70%; in weeks 7 and 9: 2-sets, 10-repetition, rest Work rest ratio: 1:4, with the intensity of 70 to 75%, and ending with weeks 10 and 12 performing between 2-sets, 12-repetition, Work rest ratio: 1:4, with the intensity of 75 to 80%. The program began after the adaptation period and the initial and final ten minutes were always used to warm-up and cool-down respectively.

Table I: Speed, Agility and Quickness Training program (SAQ)

S. No	SAQ TRAINING EXERCISES	Week 1 to 3	Week 4 to 6	Week 7 to 9	Week 10 to 12
	SPEED	Vol:3set, 6rep, rest 1:3 No. of Exercise three from each motor fitness Variables	Vol:3 set, 8rep, rest 1:3 No. of Exercise three from each motor fitness Variables	Vol: 2 set, 10rep, rest 1:4 No. of Exercise three from each motor fitness Variables	Vol:2set, 12rep, rest 1:4 No. of Exercise three from each motor fitness Variables
1.	Gears				
2.	Bounding				
3.	A – Skips				
4.	Skip for Height				
5.	Harness pull				
	AGILITY				
6.	20-Yards Shuttle				
7.	Zigzag				
8.	Five-Cone Snake Drill				
9.	Cartwheel				
10.	Crossover Shuffle				
	QUICKNESS				
11.	Back Pedal				
12.	Wheel Barrow Drill				
13.	In Place Tuck Jump				
14.	One leg Hop				
15.	Barrier Jumps				

Results

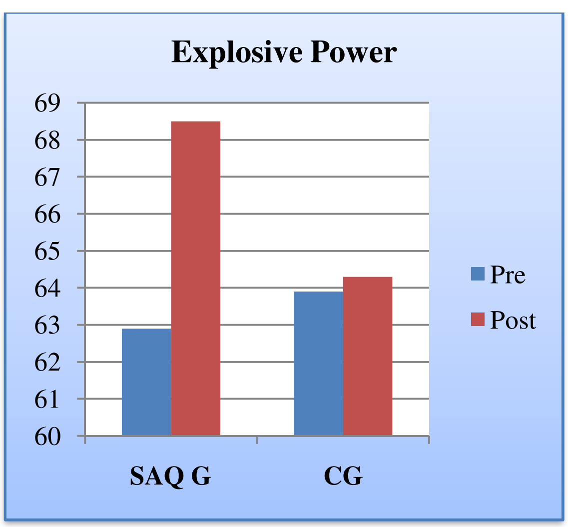
The results presented in Table II proved that the experimental and control groups were well matched on the pre-training tests with no significant differences found on explosive power (62.90) and agility (63.90)variable between the two groups. The experimental group significantly improved their performance from pre- to post-training on explosive power (68.50) and agility (64.30). Further, it proved that the performance in the control group remained similar in both explosive power and agility. It was proved that 12 weeks of Speed, Agility and Quickness (SAQ) training had positive effects on explosive power and agility in junior badminton players.

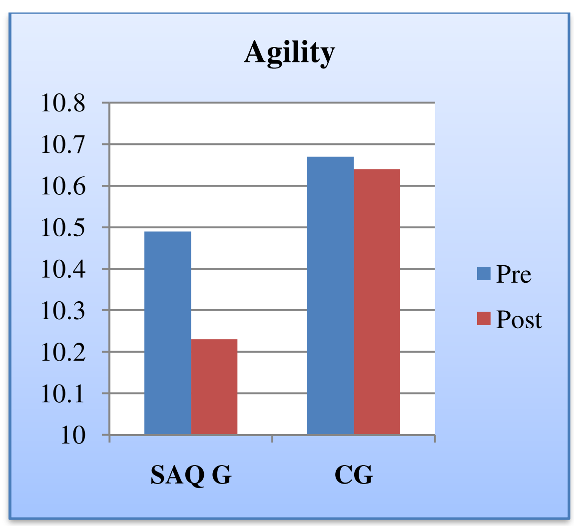
Table II: Efficacy of Speed, Agility and Quickness Training on Explosive Power and Agility among Junior Badminton Players

Explosive Power	(Scores in centimeters)							
		SAQ G	**CG**	**S V**	**SS**	**df**	**MS**	**Obtained F**
	Pre Test	62.90	63.90	B	5.00	1	5.000	1.03
				W	87.80	18	4.88	
	Post Test	68.50	64.30	B	88.20	1	88.20	**20.20***
				W	78.60	18	4.37	
	Adjusted	68.93	63.87	B	121.28	1	121.28	**156.67***
				W	13.16	17	0.77	
	Mean Gain	-5.60	-0.40					
Agility	(Scores in seconds)							
	Pre Test	10.49	10.67	B	0.16	1	0.162	1.48
				W	1.97	18	0.11	
	Post Test	10.23	10.64	B	0.84	1	0.84	**8.48***
				W	1.79	18	0.10	
	Adjusted	10.31	10.56	B	0.28	1	0.28	**41.51***
				W	0.11	17	0.01	
	Mean Gain	0.26	0.03					

*Significant at 0.05 level of confidence

Figures: Pre and Post Test Mean scores on Explosive Power and Agility among Junior Badminton Players





Discussion

In the present study the Speed, Agility and Quickness (SAQ) training has improved the explosive power and agility over respectively by finding significant differences in comparison from baseline to post test. The results of this study indicated that selected Speed, Agility and Quickness (SAQ) is more efficient to bring out desirable changes over on explosive power and agility of junior badminton players, the finding of the present study had similarity with the finding of the investigator referred in this study Milanovic, et al., (2013) SAQ training plays a major role in enhancing agility, with and without the ball and can be considered for physical conditioning programmes. Further, Sudha, et al., (2012) proved that there is a substantial training enhancement was noticed in the speed, power and agility of handball players who performed SAQ training than the control group. The result also put forward that this training can be considered as an asset in the physical conditioning programs. Bloomfield, et al., (2007) determined that the SAQ training is an efficient method to improve dynamic balance and leg power and another study conducted by Jovanovic, et al., (2011) they found that eight weeks SAQ training was significantly improved in power performance due to the influence of SAQ training among soccer players. The results of this study agree with the study of Chandrakumar and Ramesh, (2015) who suggested that the SAQ training is very much effective for improving the speed and strength or capability for exerting optimum force during quick multi-directional movements. The results of the present study indicate that the Speed, Agility and Quickness (SAQ) methods of training is more appropriate training protocol to improve explosive power and agility of junior badminton players.

Conclusion

Based on the result of the study it is concluded that the 12 weeks SAQ training have been significantly improved explosive power and agility among junior badminton players. From the finding it is suggested that Speed, Agility and Quickness (SAQ) methods of training is suitable mode to bring out desirable change over explosive power and agility among junior badminton players.

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NUMERICAL AND EXPERIMENTAL VERIFICATION OF STRAIN MEASUREMENT ON THE PLAYER ARM DUE TO IMPACT OF BALL ON CRICKET BAT

By

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ABSTRACT

Cricket is one of the most popular games among young players in the world. The game result is purely based on the runs which are taken by the team. Hence the players will put maximum effort to score high runs as much as possible. The effort is nothing but how much force the players can exert on the bat while hitting the ball so that the ball can travel maximum distance in the ground. The average velocity of the ball thrown by the bowler is in the range of 40 km/h to 150 km/h which depends on the bowling speed of the bowler. Due to such high velocity of the ball hitting on the bat, high impact force is generated on the bat as well as on the arm of the player. This paper studies the strain, stress and energy due to ball impact force with different velocities using numerical method. Also experimental verification for strain measurement is done in real time with data acquisition devices.

Keywords: Cricket, Velocity, Impact Force, Strain, Stress, Energy.

INTRODUCTION

Sports always play a major role in human life and with the advent of new technology it is gaining importance in recent years. There is an increasing need in research and development for a theoretical cricket ball model that can be incorporated in the analysis of bat impact stresses, deformations and durability. The models developed would be useful to comprehend the impact details deeply so as to provide some data to avoid sports injuries. The magnitude of vibration on the muscles during various strokes may lead to strain and overload the players. In games such as cricket the delivery speed of the ball is greater than 150 kmph for fast bowling. The batsman has to release a proper shot to encounter the ball coming with such high velocity. There are possibilities for the arm to get strained.

Measuring the muscle activity at this point gains importance. Sometimes overstrain might lead to injuries for the player. A model has been developed to find out the vibrations of the bat during the collision between the bat and baseball (Nathan, 2000). The parameters like wrist vibration, swing velocity and forearm muscle activation while hitting baseballs were investigated in the study (Yang et al., 2021). Many previous literature surveys referred to study related to baseball. The performance of batted ball has been analyzed for baseball bats using the vibration data's (Sutton & Sherwood, 2010). There are regions in the bat where the exit velocity of the ball is a function of impact location and these regions are considered to be more important. This concept has been experimentally proved for a cricket batsman where the accelerometer readings were high showing the existence of sweet spot locations. These accelerometers were wrist mounted (Sarkar et al., 2012). The fatigue analysis for cricket bat has been done for the ball coming up with various velocities (Brooks et al., 2006). The location of minimum amplitude of vibration has been found on the bat (Hariharan & Srinivasan, 2012).

Seshadri et al. (2019) proposed a methodology to measure strain using strain gauge sensor where the data acquisition is done by low cost microcontrollers. The results obtained were satisfactory and has been verified by using finite element analysis software. Ul-Haq et al. (2017) explained how the strain gauges were used to detect muscle contractions and showed a better result compared with electromyography sensors. Continuous excessive strain in ankle joints will lead to tear in ligaments. Houghton et al. (2011) measured the strain by applying various degrees of stress to the ankle joint and stated the maximum strain rate. Pote and Christie (2016) explained how the strain gauge sensors were used to find the muscle contractions, which were directly related to change in length of the sensor during muscle contractions.

1. Force Analysis Calculation

From the cricket data base, it is observed that the speed of the cricket ball is in the range of 40 km/h to 150 km/h. Considering this as input, the ball velocity is calculated for the respective ball speed as shown in Table 1.

The ball hitting force or impact force of the ball is calculated from the following equations.

Mass of the Cricket ball = 163 g

Maximum velocity of the ball while bowling = 150 km/h

= 41.66 m/s

Sl. No	Ball Speed (km/h)	Ball Velocity (m/s) (From bowler)	Hitting Force (N)
1	40	11.11	2778
2	50	13.89	3472
3	60	16.67	4167
4	70	19.44	4861
5	80	22.22	5556
6	90	25.00	6250
7	100	27.78	6944
8	110	30.56	7639
9	120	33.33	8333
10	130	36.11	9028
11	140	38.89	9722
12	150	41.67	10417

Table 1. Calculation of Hitting Force

$$\text{Acceleration} = \frac{\text{Change in velocity}}{\text{Ball Hitting Time}} = \frac{41.66}{0.0006} = 69433\, m/s^2$$

Ball hitting force = Mass of the ball *Acceleration

= 0.15 * 69433

Ball hitting force = 10415 N

Figure 1 shows a plot of the ball hitting force for the different ball speed. It is inferred from the graph that the ball hitting force is directly proportional to the ball speed.

2. Modeling of Cricket Bat

To predict the effect of the ball hitting force on the bat and human arm, finite element analysis is carried out using ANSYS software. The cricket bat is made up of English Willow Wood and orthotropic material property is considered in the finite element analysis. The material properties are listed in Table 2.

Figure 2 shows a typical Willow Wood cricket bat which is modeled using 3D modeling software-Cero. The bat is modeled using solid element with 3 degree of freedom along the three directions x, y and z as shown in Figure 3. The pull shot in cricket played by a player is shown in Figure 4. The boundary conditions are arrived from the pull shot as shown in Figure 5.

To simulate the ball hitting on the bat, the impact force at different ball speed is applied on the bat as shown in

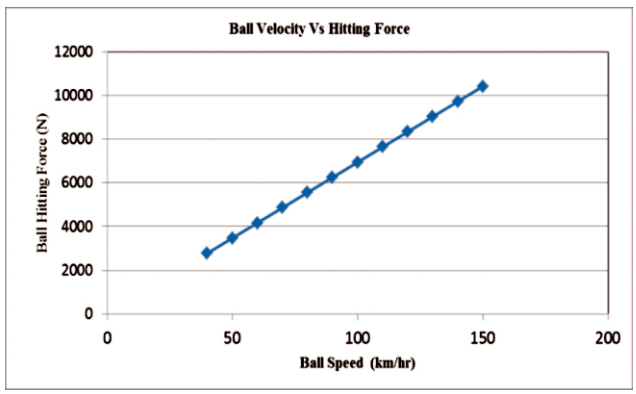

Figure 1. Ball Velocity vs Ball Hitting Force

Young's Modulus (N/mm^2)			Poisson's Ratio			Shear Modulus (N/mm^2)			Density (kg/m^3)
Ex	Ey	Ez	ux	uy	uz	Gxy	Gyz	Gzx	ρ
13000	883	7060	0.015	0.3	0.16	7170	6288	6288	800

Table 2. Material Properties of English Willow Wood Bat

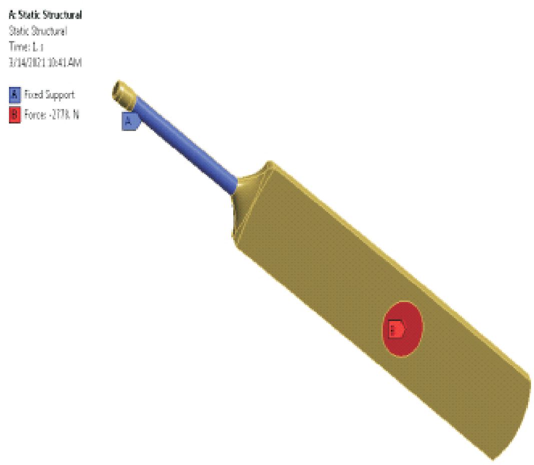

Figure 2. A Typical Cricket Bat

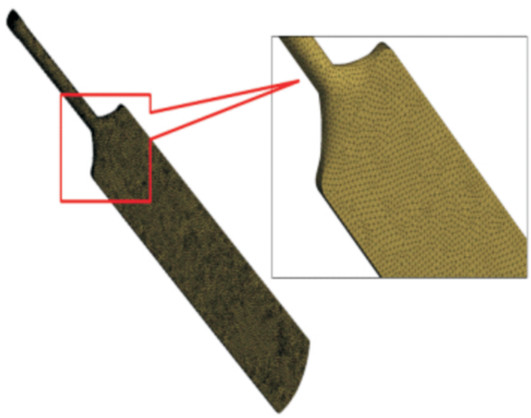

Figure 3. Finite Element Model

Figure 4. Cricket Player Pull Shot

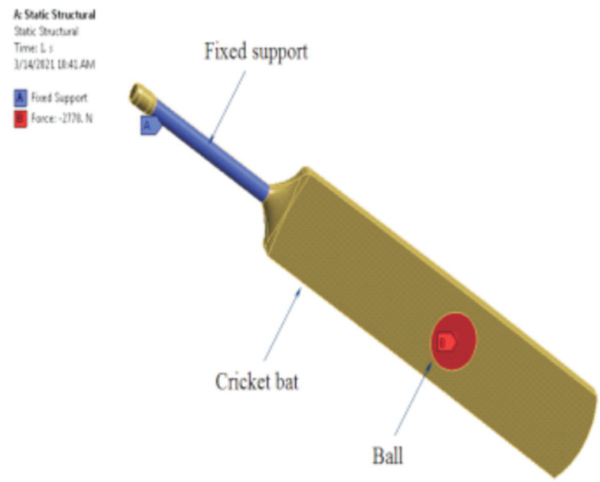

Figure 5. Boundary Condition

Figure 6. The impact force for minimum ball speed of 40 km/h is 2778 N and maximum ball speed 150 km/h is around 10417 N. After applying the loading and boundary condition, the model is solved using ANSYS and results are obtained.

Figure 7, 8, 9 and 10 shows the stress and strain details for ball velocities ranging from 40 km/h to 150 km/h. Figure 11 shows the calculation of reaction force in all three directions (x, y and z). Maximum reaction force is observed during pull shot that is along y-direction. Figure 12 shows that the stress induced in the arm has direct relation to the velocity of the ball. There exist an energy exchange mechanisms between the ball, striking bat and the player arm. Figure 13 shows the energy exerted from the bat due to ball hitting.

3. Experimental Strain Measurement

In order to verify the results obtained using the numerical analysis, a verification of the same is done using LabVIEW and NI data acquisition devices (DAQ). The strain gauge sensors are placed on human arm and it is connected to the data acquisition device. The NI 9236 has in-built excitation voltage and has required signal conditioning to perform the dynamic strain measurement. The device rejects the common mode noise effectively and measures strain instantly in real time.

Figure 14 shows the strain measurement in the arm of batsman developed in hitting the ball coming with various

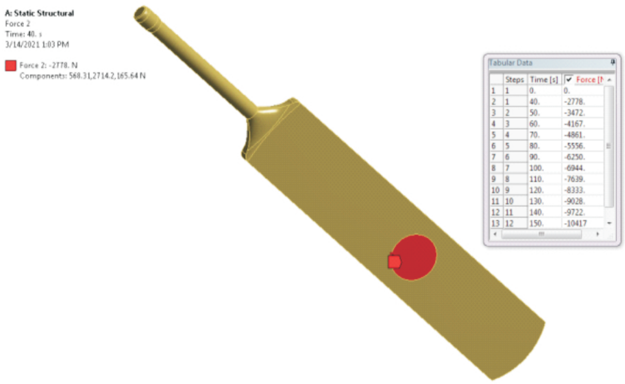

Figure 6. Impact Force

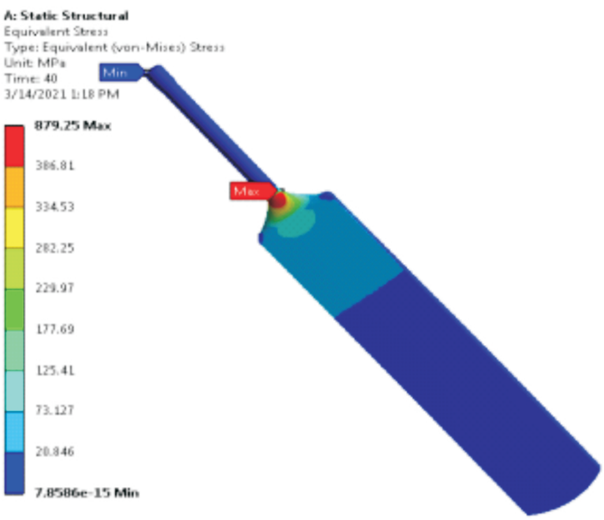

Figure 7. Von-Mises Stress @ Ball Velocity 40 km/h

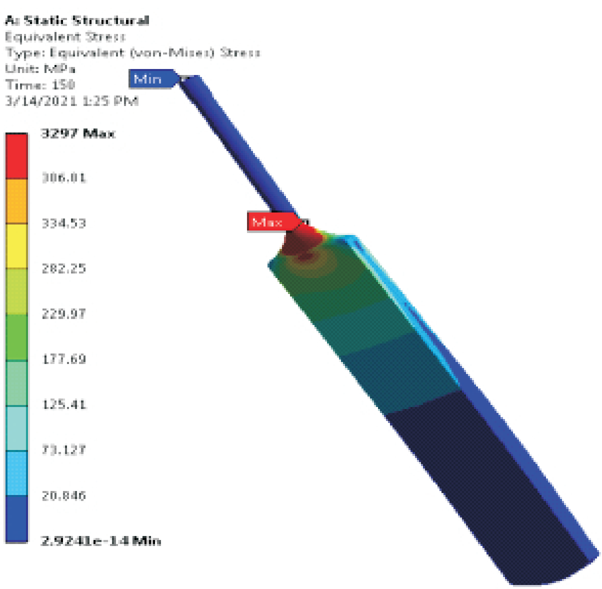

Figure 8. Strain @ Ball Velocity 40 km/h

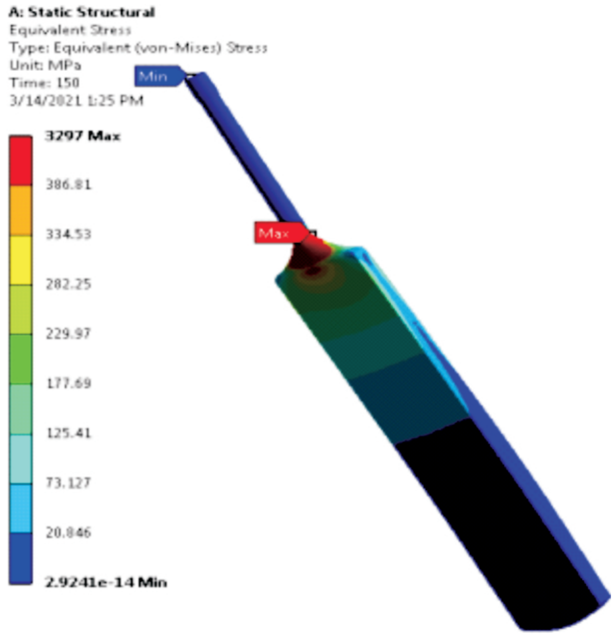

Figure 9. Von-Mises Stress @ Ball Velocity 150 km/h

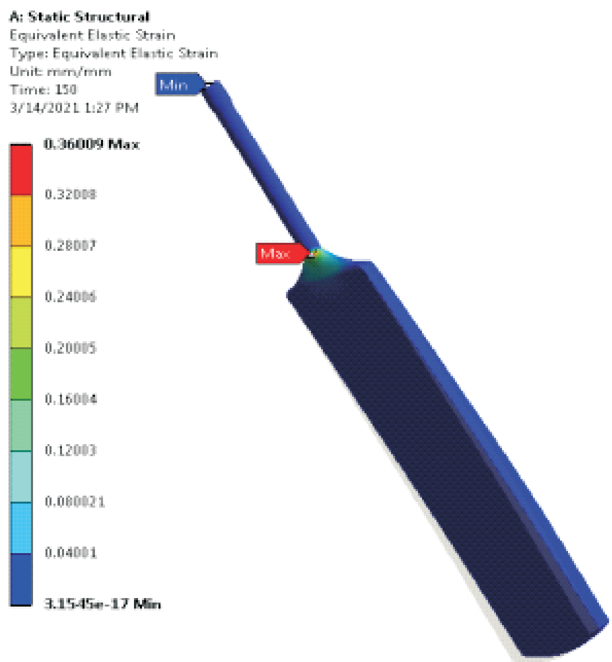

Figure 10. Strain @ Ball velocity 150 km/h

velocities. This strain value is measured with the data acquisition device.

4. Results and Discussion

Figure 15 shows the comparison on the numerical and experimental analysis on the ball velocity verses strain. In numerical analysis the strain is directly proportional to the

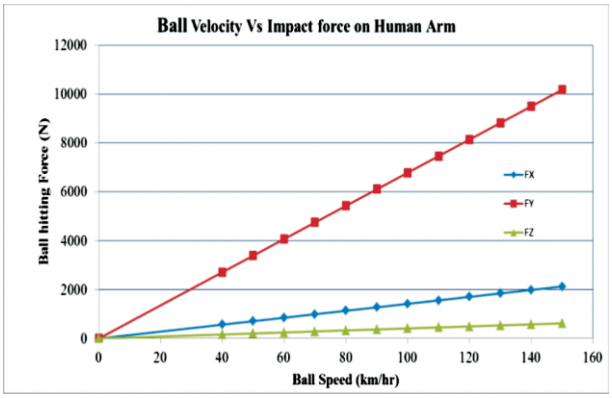

Figure 11. Reaction Force on the Arm Due to Ball Hitting

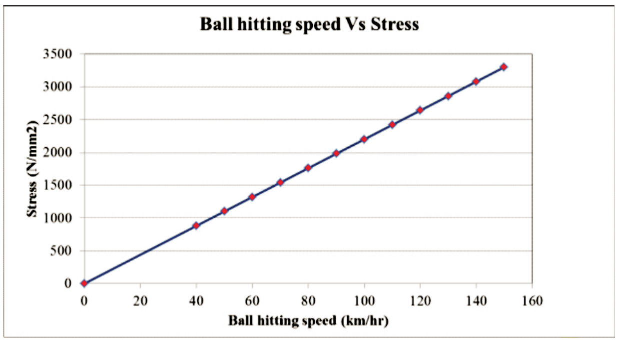

Figure 12. Stress Due to Ball Hitting

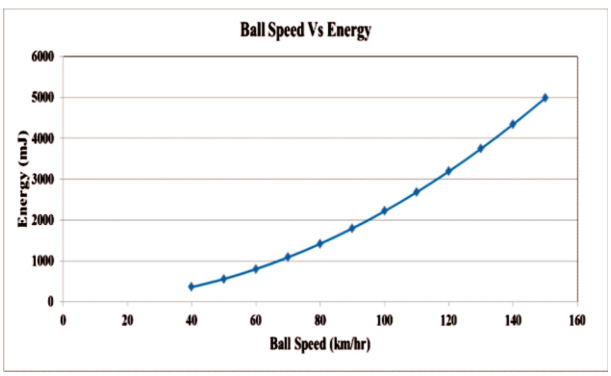

Figure 13. Energy Consumed During Ball Hitting

ball velocity. But in experimental analysis there are some fluctuations. This is due to manual measurement variation and strain gauge variability.

From the experimental strain measurement it is observed that the maximum strain for the ball coming with a velocity of 50 km/h is 0.12, for a velocity of 100 km/h is 0.23 and for a velocity of 110 km/h the strain measured is 0.252.

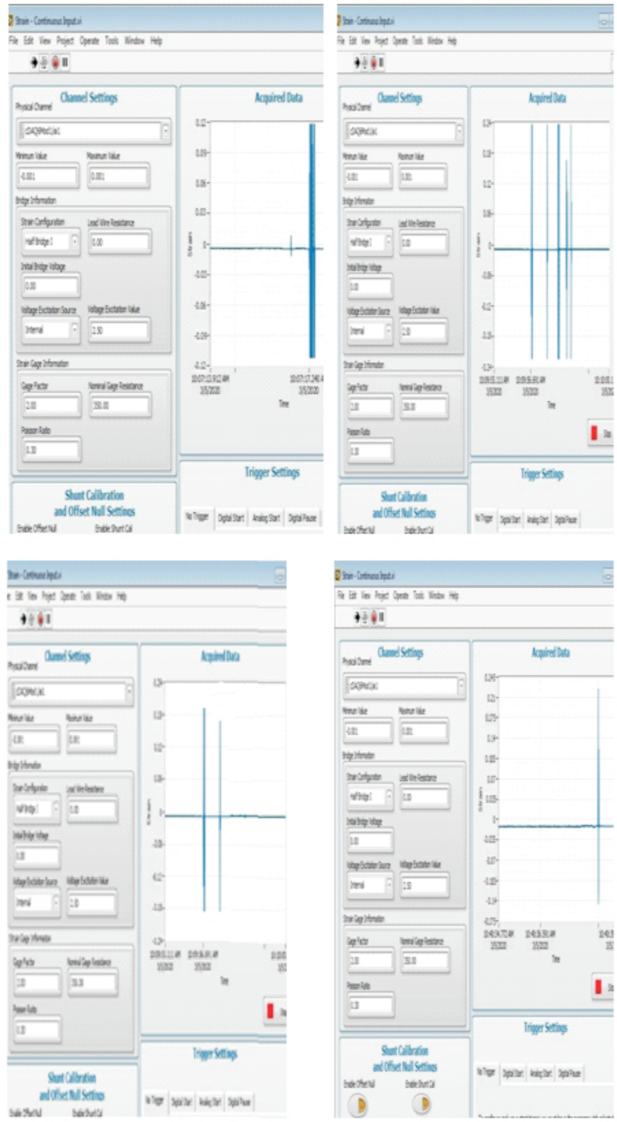

Figure 14. Strain Measurements from Data Acquisition Device for Various Ball Velocity

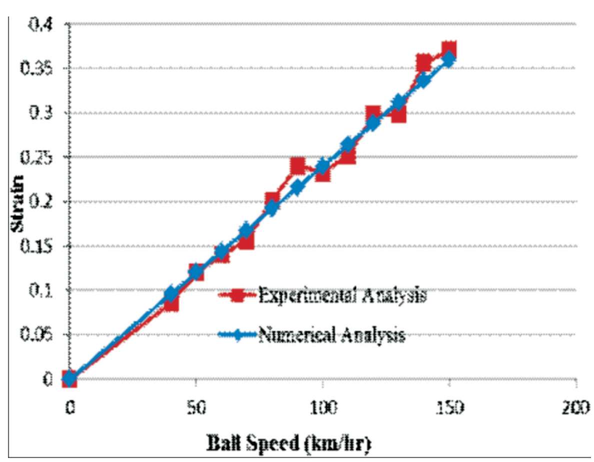

Figure 15. Ball Velocity vs Strain

Conclusion

In this work the impact force is calculated for different ball speed in the range of 40 km/h to 150 km/h. The bat is modeled using numerical method and orthotropic material properties are considered for the bat material. Impact force is calculated using ball mass, speed and hitting time.

The stress and strain values are calculated for various ball hitting forces. Also reaction force at the time of ball hitting on the bat is calculated. The reaction force experienced by the bat handle is directly transferred to the player hand.

In order to verify the numerical results experimental strain measurement is carried out using DAQ. There is a good correlation between the numerical analysis results and experimental results and it is observed that the variation is less than 5%. The measured data will be useful for predicting the injury in the arm of sports player. In future machine learning algorithms can be developed to predict the strain in arm of a player while playing his game.

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Hardware Implementation of PV fed boost converter with quasi resonant voltage doubler and snubber circuit

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Abstract— In this article, hardware implementation of PV fed boost converter with quasi resonant voltage double and snubber circuit is presented. This method clarifies the improvement of a boost half-bridge (BHB) DC-DC converter with high power transformation efficiency and a wide voltage range for photovoltaic smaller scale inverter. The improvement is accomplished by presenting an isolation Transformer, interfacing the BHB DC-DC converter on the essential side of the transformer and including a voltage doubler with a snubber capacitor on the auxiliary side. Quasi Resonance (QR) strategies are utilized to accomplish zero-voltage exchanging (ZVS) turn-on for the switches, just as ZVS turn-on for the diodes. Furthermore, the new improved converter has no DC-charging current for the transformer because of the DC blocking capacitor, and it duplicates the voltage increase through the voltage doubler and snubber capacitor to diminish spikes Further, an extensive hardware validation show the effectiveness of the system.

Keywords— Photo voltaic Systems, Micro Inverter, DC-DC Converter, Quasi Resonance, Power Conversion.

I. INTRODUCTION

Lately numerous nations satisfy the power need, so the age of renewable power source is expanded, for example, photovoltaic, wind, fuel and so on. The sun gives all that anyone could need vitality to meet the entire world's vitality needs, and not at all like petroleum products, it won't run out at any point in the near future [1-2]. As a sustainable power source, the main impediment of sun oriented force is our capacity to transform it into power in a proficient and savvy way. No ozone depleting substance emanations are discharged into the environment when you utilize sun powered boards to make power. Also, on the grounds that the sun gives more vitality than we'll ever require, power from sun based force is a significant vitality source in the transition to clean vitality creation. After sun based boards have been introduced, operational expenses are very low contrasted with different types of intensity age. Fuel isn't required, and this implies sun based force can make huge sums of power without the vulnerability and cost of verifying a fuel supply. The progression up DC-DC converter for a smaller scale inverter must have a high voltage gain G (V_O/V_{IN}) of a few tens or more [3-4]. In this manner, if a traditional DC-DC help converter is utilized for a small scale inverter, the switch must have an incredibly high duty ratio. Be that as it may, this outcomes in huge current flows, losses due to conduction, and losses due to switching losses of the electric influence segments in the converter. Non-isolated DC-DC converters have been concentrated to defeat these issues in Step-up DC-DC Converters above [5-7].

To accomplish high voltage gain without an amazingly high duty ratio of the principle switch, non-isolated converters utilize detached and dynamic parts rather than a transformer. In any case, non-isolated DC-DC Converters have complex structure, electro-attractive obstruction, grid current contortion, and extra misfortunes because of the spillage current produced by the galvanic association between the PV module and grid [8-9]. The traditional flyback converter has the littlest circuit parts and circuit size. In any case, it has burdens of the low voltage increase, high voltage worry of the rectifier diode, and high voltage spike issue of switch[10-11]. To take care of these issues, the dynamic clamp flyback converter with a voltage doubler was presented.

The proposed converter utilizes the quasi-resonance among C_1 and L_{lk}. Contrasted with the past converter it can decrease the turn off current of S_1 and obligation loss of the circuit in view of the quasi-resonance among C_1 and L_{lk}. Along these lines, this converter of has the littler turn off misfortunes and more extensive voltage at the input side run than that of past converter

PROPOSED SYSTEM

In proposed system shown in Fig 1 the PV panel input voltge is fed to the DC load with the help of half bridge boost converter which converts the DC voltage with AC voltage with some boost ratio and then it converted AC voltage is stepped up using turns ratio of transformer and then voltage doubler circuit converts the doubles the AC voltage to DC voltage which drives the load.

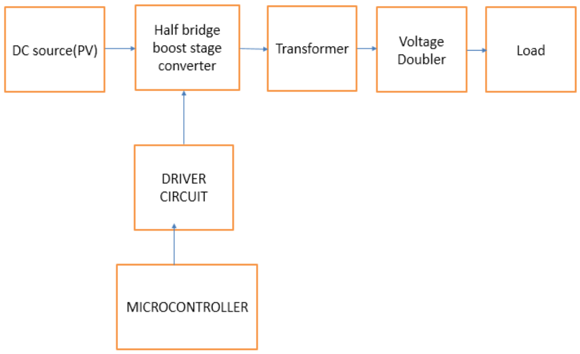

Fig 1. Block Diagram of Proposed System

The siwtching pulses to the switch is given by microcontroller which is amplified by the driver circuit.

II. MODELS

A. PROPOSED CONVERTER

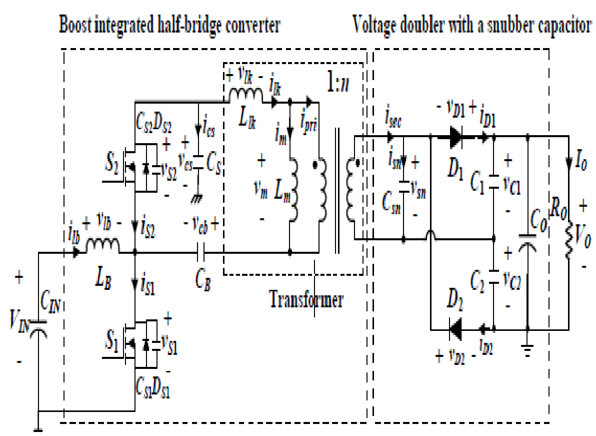

Fig 2. Circuit Diagram of Quasi Z source inverter

The proposed converter has a combined structure of a boost integrated half-bridge converter on the primary side of the transformer and a voltage doubler with a snubber capacitor on the secondary side. The boost integrated half-bridge converter consists of a boost inductor (L_b), two switches (S_1, S2), a storage capacitor (C_s), a blocking capacitor (C_b), and a transformer with a leakage inductance (L_{lk}), turn ratio of 1:n, and a magnetizing inductance (L_m). It performs the operation of the boost converter of stepping up the input voltage (V_{in}) to the higher voltage (V_{Cs}) of C_s. It then performs the operation of the half-bridge converter of transferring the electric energy from Cs to the load (R_0). An Isolation Transformer is used to step up the Voltage of BHB Converter. The voltage doubler with a snubber capacitor consists of two diodes (D_1, D_2), a snubber capacitors (C_{sn}), two capacitors(C1, C_2), and an output capacitor (C_O). It generates a DC output voltage (V_O) of twice the secondary voltage of the transformer and reduces the voltage stresses of D_1 and D_2 to V_O. The simple PWM circuit has been used to give the switching pulses to the switches. The swithces S_1 and S_2 works complemetary for giving the AC like signals. The circuit diagram of proposed converter is shown in Fig 2.

The operation includes when switch S_1 is in ON condition the positive cycle is generated, switch S_2 is responsible for the negative cycle generation. The input boost inductor L_b charges and discharges linearly with respect of switching condition of switches S_1 and S_2.

B. DRIVER CIRCUIT

A driver is an electrical circuit or other electronic component used to control another circuit or component, such as a high-power transistor, liquid crystal display (LCD), and numerous others. They are usually used to regulate current flowing through a circuit or to control other factors such as other components, some devices in the circuit. The term is often used, for example, for a specialized integrated circuit that controls high-power switches in switched-mode power converters. Typically the driver stage(s) of a circuit requires different characteristics to other circuit stages. For example in a transistor power amplifier circuit, typically the driver circuit requires current gain often the ability to discharge the following transistor bases rapidly, and low output impedance to avoid or minimize distortion.

C. MICROCONTROLLER(PIC16F877A)

The term PIC, or Peripheral Interface Controller, is the name given by Microchip Technologies to its single – chip microcontrollers. PIC micros have grown to become the most widely used microcontrollers in the 8- bit microcontroller segment. The PIC16F877A CMOS FLASH-based 8-bit microcontroller is upward compatible with the PIC16C5x, PIC12Cxxx and PIC16C7x devices. It features 200 ns instruction execution, 256 bytes of EEPROM data memory, self-programming, an ICD, 2 Comparators, 8 channels of 10-bit Analog-to-Digital (A/D) converter, 2 capture/compare/PWM functions, a synchronous serial port that can be configured as either 3-wire SPI or 2-wire I2C bus, a USART, and a Parallel Slave Port.

III. RESULTS

Fig 3 shows the overall hardware setup of proposed converter for the measurement and acquisition of Input & Output Waveforms.

Fig 3. Overall hardware setup

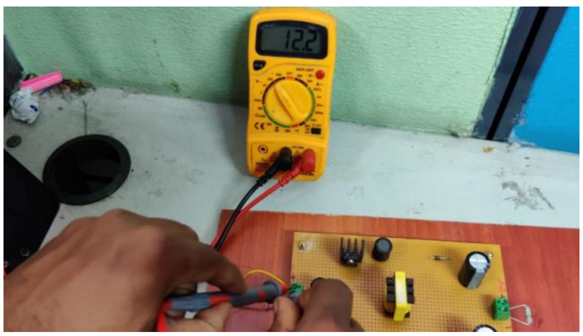

Fig 4. Input voltage of 12V

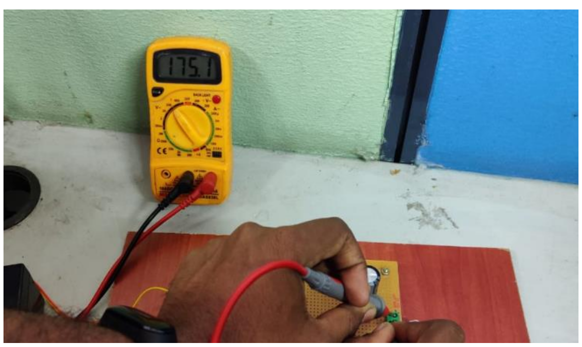

Fig 5. Output voltage of 175V

Fig 4 & 5 show the input and output voltage of proposed converter

IV. OUTPUT WAVEFORMS

The Input and Output Waveforms were captured in Digital Storage Oscilloscope (DSO). Fig 6 shows the the Input DC voltage fed from a Solar Panel or any DC source (12.5 Volts).

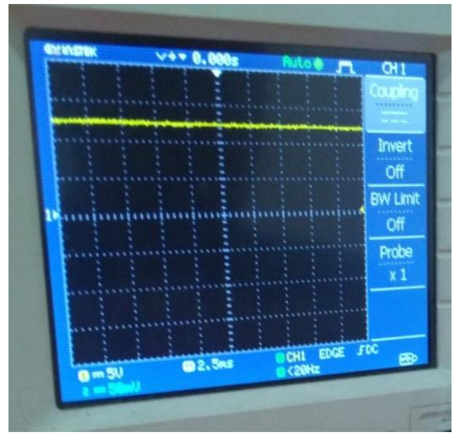

Fig 6. DC Input to BHB Converter

Fig 7 shows the Switching Pulse to MOSFET so that the DC input given to the BHB Converter Switches ON and OF the S1 & S2 pair of MOSFETS.

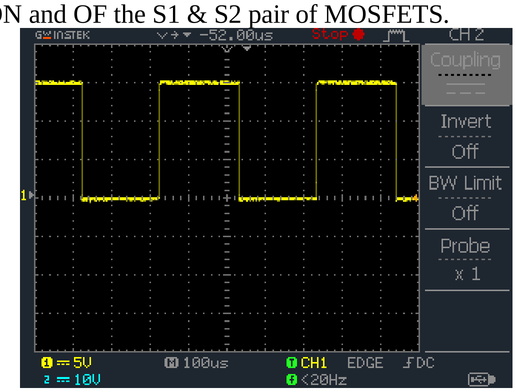

Fig 7. Switching Pulse to MOSFETs S1 & S2

The Output of BHB Converter and input to primary of the Transformer is shown in Fig 8.

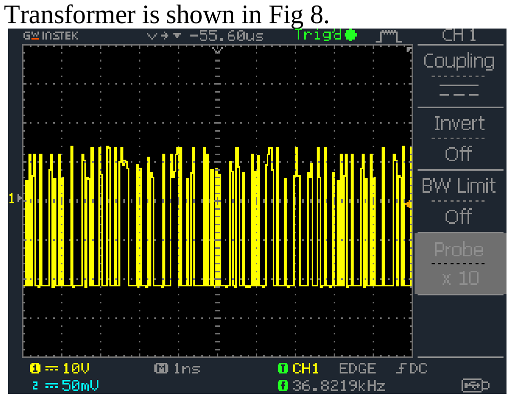

Fig 8. Input to Primary of Transformer

Fig 9 shows the waveform available in the secondary of the Transformer. The voltage is stepped up here and is fed to the Voltage Doubler.

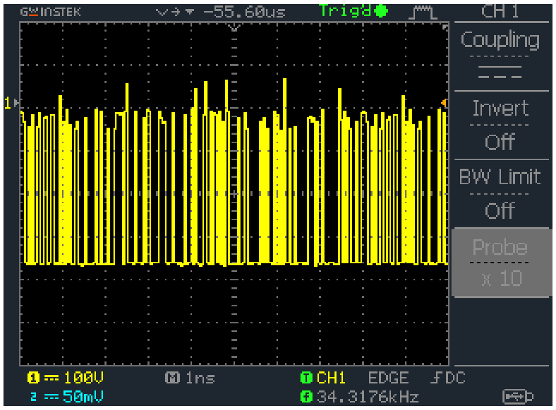

Fig 9. Voltage avaialbe at Transformer Secondary

The Voltage Doubler doubles the Voltage and then to eliminate the spikes Snubber Capacitors are introduced. Fig 10 shows the Output wave form of the Voltage Doubler and Fig 11 shows the final DC output after Snubber Circuit.

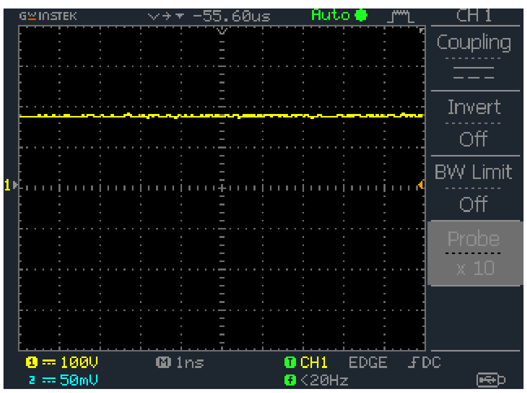

Fig 10. Output after Voltage Doubler.

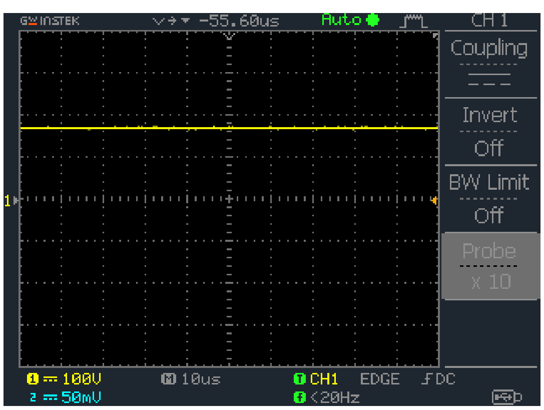

Fig 11. Final DC Output after Snubber Circuit

V. CONCLUSION

This paper presented a hardware implementation quasi-resonant boost half-bridge (BHB) DC-DC converter with high power conversion efficiency (η%) and a wide input voltage range. Moreover, the proposed converter had no DC-magnetizing current of the transformer, and the voltage gain was increased by using the voltage doubler with a snubber capacitor to reduce spikes.

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Hardware Implementation of Improvement in Power Quality by using Advanced Reactive Power Compensation

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Abstract

In this paper it is decided to improve the power quality of power supply. When the power quality is poor at load side which can cause other equipment malfunction even damages the associated devices. Therefore, a reactive power compensation method is suggested to improve the power quality in a distribution power system. To improve the power quality by using the facts device is one of the conventional methods; in our paper we inject the reactive power by using same real power supplying system.

1. Introduction

The power quality (PQ) problems and solutions to theseproblems have gained much importance in recent years.The main causes for poor power quality are: extensive use ofnonlinear loads in distribution system for efficient andcontrolled use of energy, integration of distributed generatorsbased on the renewable power (such as, solar and wind) andthe occurrence of frequent faults on the electrical network.Under the generic name of custom power devices [2] a newgroup of compensators like dynamic voltage restorer (DVR),the distribution static synchronous compensator(DST A TCOM) and unified power quality conditioner (UPQC)have been developed and used for improving power quality inthe distribution system. Some of the critical loads like dairyfood industry, chip manufacturing industry, large computer networks etc. are very sensitive to supply related powerquality problems. Voltage sags, swells, transients, unbalanceand harmonic distortion are major power quality problems in the supply voltage. These power quality problems can beeffectively compensated using a DVR.The DVR is a voltage source converter (VSC) based powerelectronics device connected in series between the supply andsensitive loads through a series transformer. It can protectsensitive loads from supply side voltage quality problems byinjecting the compensating voltage into the distribution line.When the injected voltages by DVR are in quadrature with thefeeder currents, it does not require any active power forcompensation. A small amount of active power to overcomethe DVR system losses however should be supported toachieve a self-supporting DC bus.

The disadvantage ofquadrature voltage injection is that in case of a voltagesag/swell event the restored voltage may not be in-phase withpre-sag/swell voltage and, the compensation range is highly dependent on load power factor [15].The different topologies of DVR and its protection arediscussed in [9-10]. The analysis, design and voltage injectionschemes of a self-supported DVR are explained in the [2, 11].In [11-24], different control strategies have been developed forthe control of the DVR. Some of the popular techniques are:the instantaneous reactive power theory (IRPT) [4],synchronous reference frame theory (SRFT) [12, 24], adalinebased fundamental extraction [13], instantaneous symmetrical component theory (ISCT) [14, 15], and space vectormodulation [19].The frequent unsymmetrical faults in the power systemgenerally cause the unbalanced voltage sags. To compensatefor such unbalanced voltage sags, DVR needs to injectcompensating voltages with both positive and negativesequence components. These can be achieved using twoseparate proportional-integral (PI) controllers, each for positive and negative-sequence voltages, in d-q synchronousframe [24]. The approach proposed in [24] is computationallyintensive due to the transformation from stationary frame tosynchronous frame and vice-versa.In this paper, a new control algorithm is developed based onestimation of instantaneous load reactive power for generationof reference load voltages in the stationary reference frame.The load voltages are controlled to its reference values usingPR controller in the stationary reference frame. A PR controller achieves good positive and negative-sequencefundamental voltage regulation simultaneously as it has highgains around both positive and negative-sequence fundamentalfrequencies [23]. Then implementation of DVR using VSCwith PWM control is discussed in this paper. The extensivesimulations are performed using MATLAB with its Simulink and Sim Power System (SPS) tool boxes for verifying theproposed control algorithm for DVR.

2. Materials and Methodology

In the system consists of ac source and PV panel, DC-DC converter, voltage source converter, and filter used for supplying real and reactive power without using external facts device.AC source provide the real power to the system, when there is consumption real power increase in load side to compensate the power by feed the reactive power by the voltage source inverter with use of capacitor bank.Voltage source converter, convert the dc into ac to the distribution line

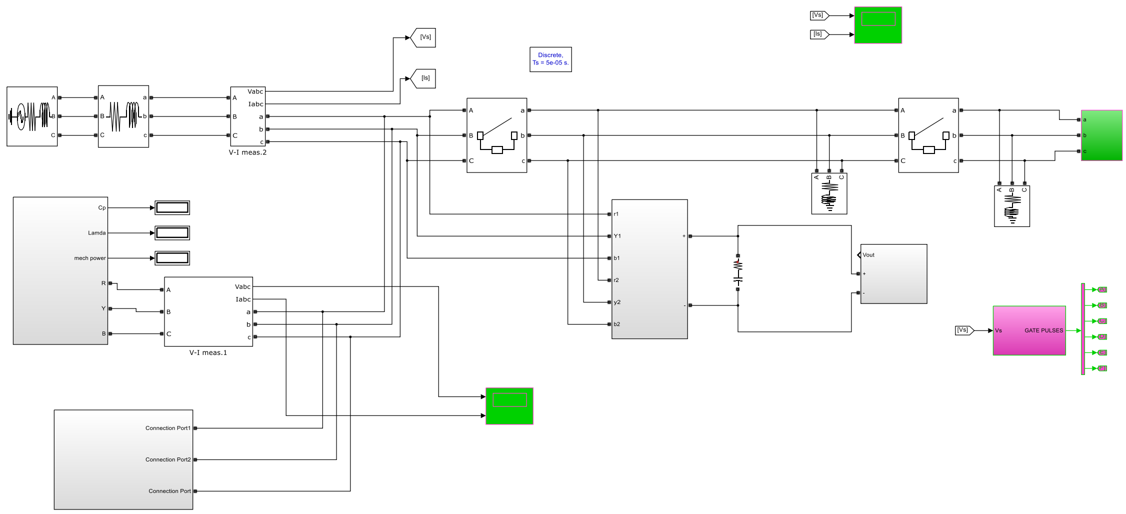

Fig.1.Simulation Diagram of the proposed system

3. Results and Discussion

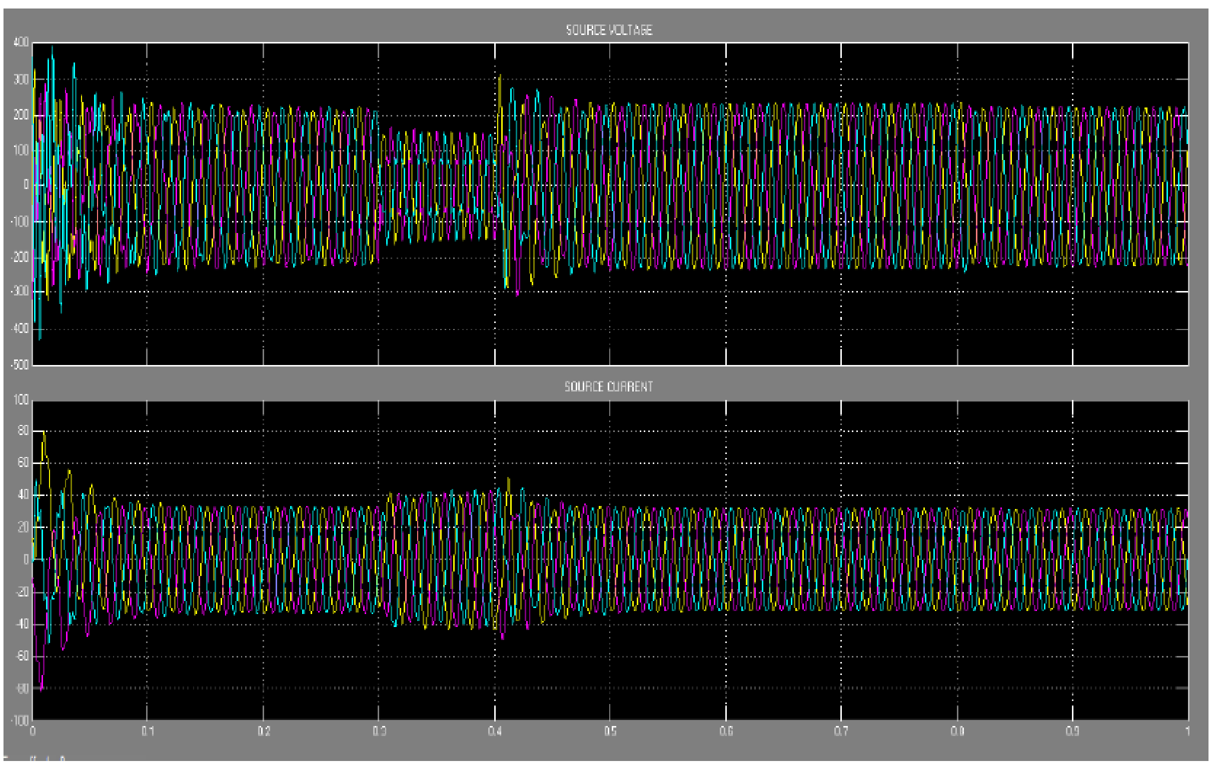

Fig.2.Source voltage before and after reactive power compensation

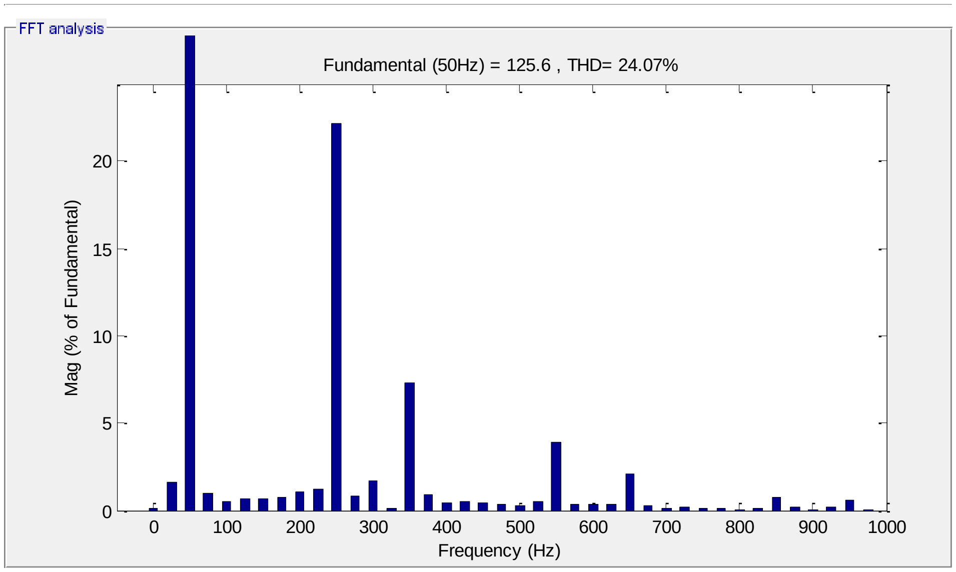

Fig.3. THD before reactive power compensation

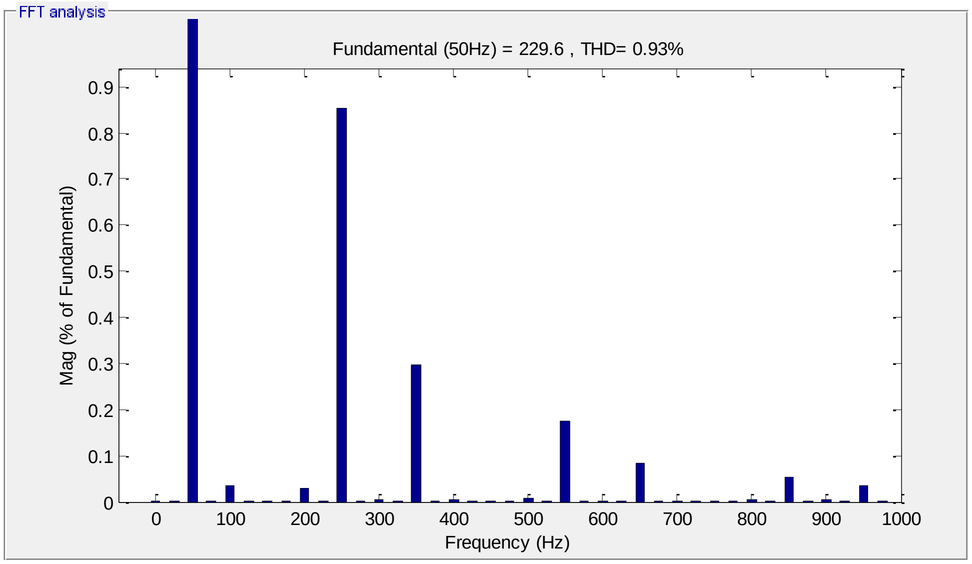

Fig.4. THD after reactive power compensation

4. Hardware Implementation

To repay the reactive power misfortunes in the transmission line and any place in the electrical influence framework, we have completed the writing survey of the different papers and embraced the distinctive procedures to defeat this issue. We have utilized the shunt and series arrangement strategies, in which the compensator like capacitor will be given in parallel and in series to the inductive load. Since there is dependably a voltage and current transient upon the changing the capacitor steps. Henceforth we adopted the FACTS (Flexible AC Transmission Systems) gadgets to beat the responsive force remuneration issue. The studies for the different FACTS gadgets were completed and we discovered the STATCOMs (Static Synchronous Compensators) is the present day and the most productive approach to conquer the responsive force pay. The different strategies were done for the STATCOMS.

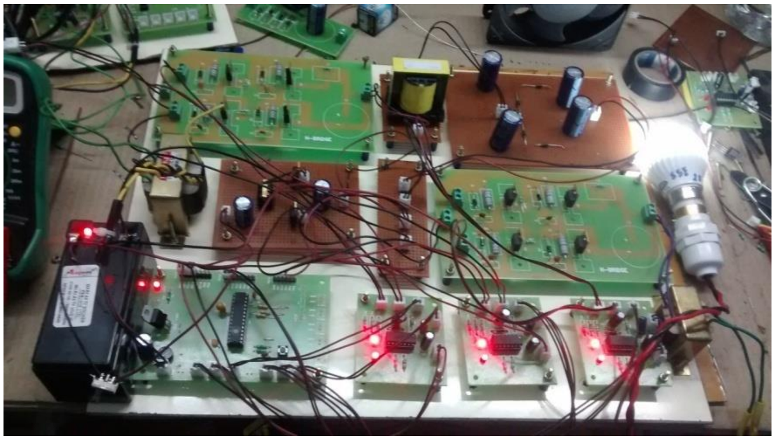

Fig.6.Hardware circuit

To compensate the reactive power in three phase AC system by using STATCOM Static Synchronous Compensator is one of the static component device and comes under the family of FACTS devices. It can absorb or supply reactive power in the single or three phase AC systems. A transmission network reactive power can be compensated using Static Synchronous Compensator. It also helps in preventing fluctuations in the transmission system like sudden voltage increase (voltage sag), sudden voltage decrease (voltage sag), transients etc. A STATCOM comprises of a three phase inverter utilizing SCRs, MOSFETs or IGBTs, a DC capacitor (which when charging will absorb reactive power and while discharging will supply 17 reactive power), a connection reactor whose purpose is to link the inverter output to the AC supply side, channel parts to channel out the high recurrence segments because of the PWM inverter. From the DC side capacitor, a three stage voltage is produced by the inverter. This is synchronized with the AC supply. The connection inductor interfaces this voltage to the AC supply side. This is the essential standard of operation of STATCOM.

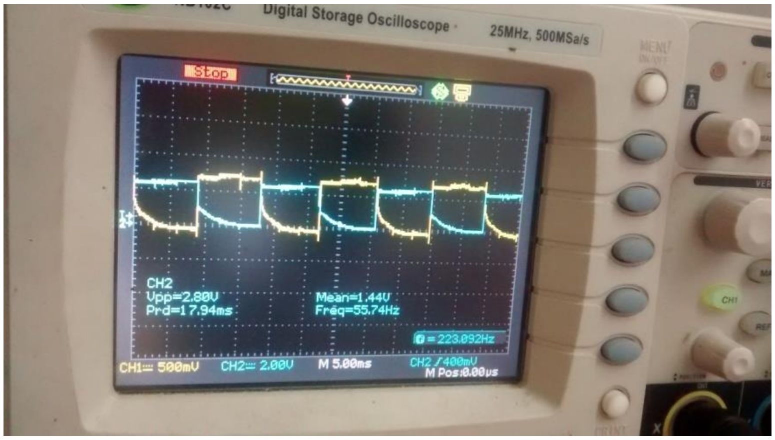

Fig.6.Before Reactive Power Compensation

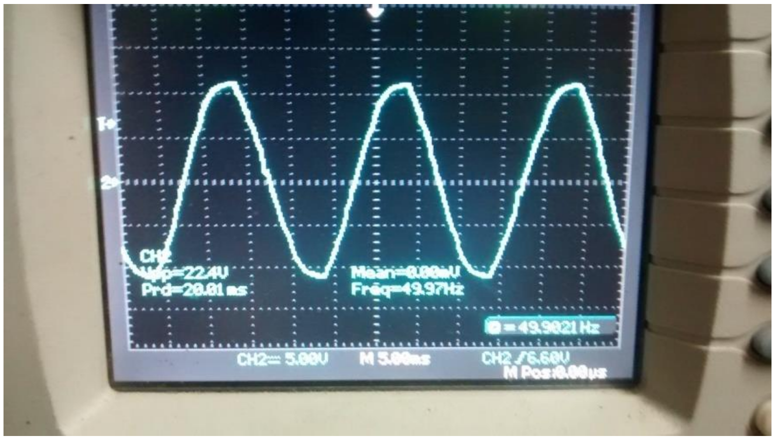

Fig.7.After Reactive Power Compensation

5. Conclusion

The reactive power compensation has been done using Renewable energy based dynamic voltage restorer and static compensator. The results of total harmonic distortion(THD) have been utilized to verify the simulation results. In this article PV based FACTS device has been successfully applied for reactive power compensation, the THD level before compensation is 24.07%, and after reactive power compensation it has been improved to 0.93%.

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Intelligent Door Knocking Security System Using IOT

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Abstract: In current day security is very important. Nowadays, in all places many robberies are going on. In this security issue, lock is the major parameter. The trustworthy on the lock should me made improve. The lock may be for main door lock, baggage lock, shutter lock, grill door lock, interconnecting door lock etc. This project is based on arduino board and IOT. And also this can be used for main door and for locker door. This lock works based on the knocking pattern. The owners knocking pattern is stored in the register. When the knocking pattern is detected by the sensor, it passes it to the arduino board microcontroller. Based on the trustworthiness of the pattern the lock works. This framework is easy for installation. It can be implemented for commercial use also.

Keywords: IOT, Arduino Uno board, Power supply, Bylynk App, DC motor, Motor driver circuit, Knock pattern, GSM module.

1. Introduction

The World has progressed significantly throughout the years and it has changed the manner in which we live, the manner in which we impart, the manner in which we learn and the manner in which we change. One of those extraordinary headways is progression in Technology. From creation of things like blades out of rocks to things like 3D printer to a super PC, Technology has made some amazing progress. This headway in Technology has been outstanding in the 21st Century.

Be that as it may, with the points of interest and advantages, additionally came the disservices and difficulties. One of the instances of this headway can be taken as the creation of the IPhone. IPhone was a noteworthy redesign from the customary sort of utilizing a telephone since it was ready to call and content as well as had the capacity to play music, recordings, and download applications. Despite the fact that these were the favourable circumstances, there were numerous detriments like battery channel and the decline of vis-à-vis correspondence because of dependence on the cell phone. With such headways in innovation, there's dependably a requirement for security and protection.

One of the methods for verifying security is a mix of ‘lock and key'. Present day locks and the locking framework are unquestionably increasingly intricate and regularly utilize a dabbed system on the key which give a more prominent security. In any case, the drawback is that it's the equivalent 'lock and key' system, which means, the key can generally be imitated with some exertion. One of the arrangements is to totally dispose of the 'lock and key' instrument itself. This venture plans to do likewise by setting up solid security basing on a 'Mystery thumping example', therefore the name, "Thump Based Security System". This framework is involved gadgets like Arduino, GSM Module , Servo Motor and so forth and utilizations a 'Mystery Knocking Pattern' which is known just to the proprietor of that specific safe, bag or some other Property or item that the gadget is introduced on. The expansion in security in executing this framework comes into the image in a few different ways.

2. Existing Systems

RFID technology can be used in the intelligent door knocking system. When anybody tries to open or knocks the door then this action will be sensed and sends information to the user via GSM. But anyone with the false RFID can open door. In finger print method, door will be opened when unique graphical security must be matched. If the culprit has the finger print then they can easily open the door.

In another method, the wireless LAN module fixed on the board receives the transmitted signal and transmits to the microcontroller. The microcontroller passes the data to the servo motor in order to complete the operations on the Door [1].

In thump impression technique, when we thump it, the arduino begins observing the primary thump to secondary thump and keeps the time gap period. In this work 6 thump impressions are taken. Therefore 5 timespans will come. These time lapses were converted interms of variables. Example, if the time period is less than 500ms, then 0. If it is more than 500ms then 1. Like this the total 5 time lapses, converted into 5 digit password. These passwords are used to open the door lock. If it does not match, then lock will not be open.

3. Proposed System

If the entry way thump is entered correctly then the gate will be open. If the thump entry is wrong for consecutive three times then code will be locked and alert will transmitted to approved authenticated client.

Working Principle

In this project work, as an input device capacitive sensor is used. This sensor can detect the electrical capacitance of the human hand. This sensor is built by using aluminium foil, medium to high esteem resistor, wire and a capacitor. When touch sensor contacts with the finger the body capacitance is in parallel to the sensor's capacitance. This makes wavering recurrence decline. The microcontroller recognizes this property.

Here, 3 bits of aluminium foils are introduced on the external side of entry way. The clients can open the entry way by contacting these foils. Because of the usage of three foils, the detection of multifaceted of the finger is possible.

Here, the time period is characterized by RC. Where, R is the resistor, C is the capacitance of the foil. In this system we have to consider the capacitance experienced by the human finger. Suitable rearrangement can balance out sensor readings, making the entire framework solid.

Other than, microcontroller, voltage converter or comparator can be used. This framework can be further improved by using a touch cushion rather than aluminium foils. For example, if the independent momentary capacitive touch sensor used then it can send computerized flag specifically to microcontroller.

BLOCK DIAGRAM & DESCRIPTION

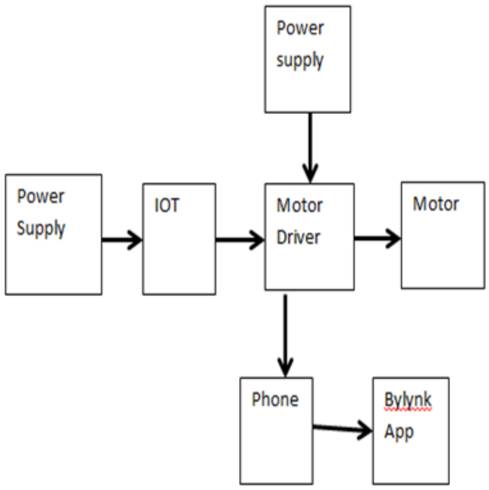

Fig. 1 Block Diagram of Intelligent Door Knocking System

In this work, the door lock is controlled by IOT and Bylynk app. The door is controlled by the motor driver. About the status of the door is delivered to the client mobile phone using bylynk app.

The description of the components are given below

IOT (Internet of Things)

It connects and exchanges the data with other devices and systems using internet. But the drawback is privacy and security. IOT can be used in consumer application field, commercial, industrial and infrastructure spaces. Recent technologies are developed in home automation systems, wearable technologies, in medical applications and remote monitoring systems.

MOTOR DRIVE MODULE:

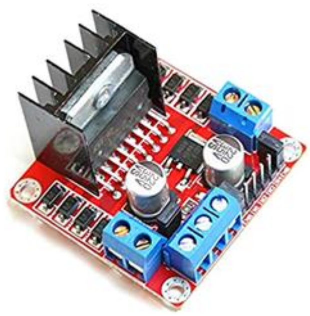

Fig 2 – L298N Motor Driver Module (Source: 2)

The L298N Motor Driver module consists of an L298 Motor Driver IC, 78M05 Voltage Regulator, resistors, capacitor, Power LED, 5V jumper in an integrated circuit.

When jumper is placed at that time only 78M05 voltage regulator is enabled. If the power supply is less than 12V, then the microprocessor is powered by voltage regulator. The speed control pin for Motor A is ENA and for

Motor B is ENB. The direction control pins for Motor A are IN1 & IN2 and for Motor B are IN3 & IN4. This module cab used in robotics, in stepping motors and in drive DC motors. The motor driver used in the project is shown in the Fig.2.

DC MOTOR

DC motor is operated by direct current. It converts DC electrical energy into mechanical energy. This motor works on the principle of when a magnetic field and electric field interact then the mechanical force called as motoring action is produced. Fleming's left hand rule gives the direction of rotation.

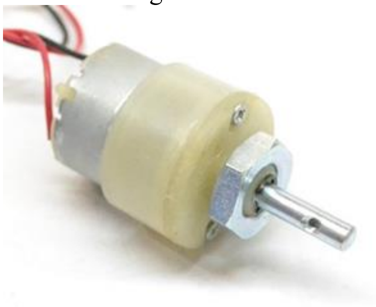

Fig. 3 – DC motor 60 RPM 12V

The Fig.3 represents the DC motor used in the project. The metal gear which is used in it has better wear and tear properties. It requires no maintenance because; the gear box is sealed and lubricated with lithium grease. It runs smoothly from 4V to 12V. It gives 60RPM at 12V.

Tests and Results

This home security system is having two stages. In first stage the client can fix where they want to mark the thump impression and successively they have to do the thump impression. In second stage, from the time gap between the thump impression code word is generated. If the code is correct then door will be unlocked.

The proposed door locks security system shown in the Figure 4. This system is attached on the door with the lock.

When the client wants to open the door, the thumping data were collected. To detect the thumping, piezo electric based vibration sensors were used. These sensor collected data transferred to the arduino. If the data was an authenticated data, then flag will be set to open the door.

All activities are connected with the client's mobile. So the status of the door was continuously monitored by the client.

If suppose any unauthenticated person trying to open the door immediately alert will be given to the client mobile. This system is shown in the Fig. 5

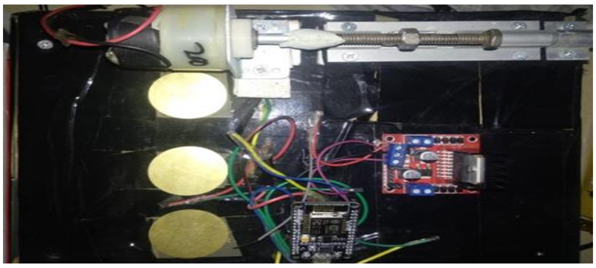

Fig. 4 Door lock security system

Fig 5: Mobile Alert using blynk app

Pros and Cons

The main drawback is if the door broken then no signal will be transmitted to the client. And the client not aware of this incident. And the advantage is, if any intruder trying to enter with wrong thumping, then alert will be sent to the client through their mobile phone.

In future, the following feature can be added with this project.

If the person is authenticated person and the client having trust then the client can open the door remotely.

4. Conclusion

Thus the proposed framework is very simple and cheaper. The accuracy of the system is very high. So the client can control the entryway remotely. The bylynk app is also a free app. Based on the thumping on the door this security systems works. In future many advanced features like, remote monitoring and contolling of the door can be achieved.

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Educational Wind Tunnel for the Sports Aerodynamics

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Abstract:
Tamil Nadu Physical Education and Sports University [TNPESU] is India's first university exclusively for physical education and sports in India includes research and courses in Sports technology and science. The Sports Aerodynamics is basic and needed research in the development of Sports products and athlete performance. TNPESU had a Wind Tunnel Laboratory for the Sports science and technology students for education and research purposes. Wind tunnel designed with the objective of analyzing different sports ball, to find the three forces and moments, Pressure distribution and the velocity streamlines in static and rotation of the ball

Keywords: *Sports University, Wind Tunnel. Athletic Performance, Sports Aerodynamics, Sports Ball*

I. INTRODUCTION

The wind tunnel is a facility used for the aerodynamics study to know the motion of air and to calculate the force and moment acting on the body. For the sports aerodynamics research and coursework, the wind tunnel is the essential facility [1].

A wind tunnel is designed based on the application, the velocity of the air in the test section and pattern or quality of the flow in the test section [1]. In the Sports Aerodynamics research the most common models are balls, disc, frisbee, cars, bikes, apparels, cyclists, athletes and stadium mostly all are tested in low Speed subsonic and Atmospheric Boundary Layer [ABL] is generated for the Stadium[1,2].

The Sports Aerodynamics wind tunnel designed and developed based on the maximum speed in the test section, test section size based on the model size with blockage ratio, not more than 5% and the space for fixing the required instruments for the wind tunnel analysis [2,3].

II. SPORTS AERODYNAMICS WIND TUNNEL

A wind tunnel is usually used for the research in Aeronautical, Space and Automobile models like airplanes, wings, rockets, missiles, cars, and trucks [2]. In recent developments in wind engineering, building aerodynamics and sports aerodynamics leads a lot of innovation in the development of the wind tunnel facility [2,3].

In sports aerodynamics wind tunnel the great challenge is to be large enough to study athletes, the length must be large to study the flow stream after the ball and to study the wind characteristics and ventilation inside the stadium[2].

The Education wind tunnel facility aim is to give knowledge and academic activities for students. We will facilitate the wind tunnel for studying sports products like different balls, shuttlecocks, frisbee, disc and apparel analysis with a feasible budget.

III. WIND TUNNEL DESIGN AND DEVELOPMENT

All low-speed Subsonic open circuit and suction type wind tunnel consist of the four main parts honeycomb with settling chamber, convergent section, test section, and divergent section. honeycomb with settling chamber will make the flow steady, linear and laminar flow into the wind tunnel[2,3]. The convergent section will reduce in cross-section area when the flow move to the test section will increase the velocity of the flow. The test section will be large enough to fit the model and measuring devices. The test section leads to the divergent section of the reduction of cross-section area with an increase in length to reduce the velocity of the flow, to avoid vibration and stress on the air suction fan blades [3].

Fig. 1. Low-speed Subsonic open circuit and suction type wind tunnel in TNPESU

Fig. 2. Honeycomb and settling chamber

The wind tunnel has a suction type, ten blade fans have coupled with an AC motor (3Ph, 440V, AC supply) with 7.5 Horse Power at maximum 1480 rotation per minute (RPM) will lead maximum flow velocity of 20 m/s in the test section.

Fig. 3. Wind tunnel fan with 10 blades

The wind tunnel different ball models have developed for education and research purpose. Each ball model was facilitated with pressure and force model. The pressure models will have a valve to connect with a multi-bank manometer or the computerized pressure transducer[4]. The force model to be fixed in Strain Gauge Balance for the measurement of the three axial forces and three moments of the model[5].

Fig. **4.** Force model on the left and pressure model

IV. Wind Tunnel Measuring Instruments and Devices

To measure the flow characteristic like pressure, flow velocity, force acts on the model and the flow streamline pattern are in need of measuring instruments and devices. The inclined multi-bank manometer filled with alcohol or water with 13 tubes will help to measure the even a small pressure difference at the model. The pitot-static tube with a

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separate manometer will measure the flow velocity in the test section through static and stagnation pressure readings[4,5]. The pitot-Static tube will move vertically up and down to verify the effect of the boundary layer due to the wall of the wind tunnel. The D3D Camera is set to observe and record the flow patterns (smoke flow) and rotation of the ball [6]. The Smoke generator will generate the linear smoke flow to visualize the flow separation, circulation and the path of the flow streamline


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Fig. 5. Wind tunnel control panel and Muti-Bank

Fig. 6. D3D Wind Tunnel Camera

Fig. 7. Smoke Generator

V. Computerization of Wind Tunnel Analysis

The latest development in the electronic instrument made the wind tunnel experiments easier, faster and accurate measurement. Pressure transducer and the Strain gauge balance play a huge role in wind tunnel experiments.

The pitot-static and the pressure models connected the pressure transducer which will display the flow velocity and pressure on the display and in the computer, where the inbuilt software will have the algorithm for the calculation

Fig. 8. Pitot-Static tube and Hotwire anemometer

The hot wire anemometer used to measure the flow velocity which works on the temperature difference due to the flow velocity in the test section. Used for the accurate measurement of the flow velocity in the test section[4].

The Strain gauge balance is used to calculate the 3 axial forces and 3 moments act on the body [3]. The Strain gauge balance mounting system not only supports the model but also rotate clockwise and anti-clockwise direction to study the different sports ball rotational effect.

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Fig. 9. Strain Gauge Balance

The computer had the software with an algorithm to calculate the Pressure distribution, forces acts on the body and the CL & CD measurements and to generate the graphs. All readings can be exported in Excel format[5,6,7].

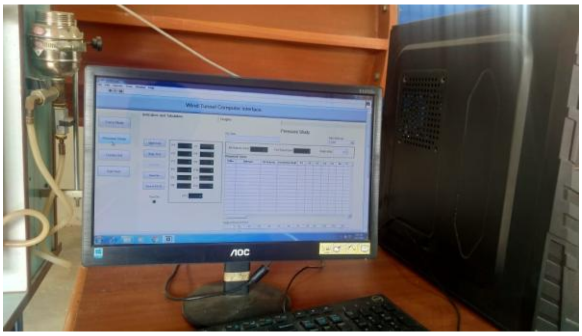

Fig.10. Wind tunnel Computer Software application

VI. CONCLUSION

The wind tunnel is an essential facility for education and research purposes in the Sports Aerodynamics program. The role of the engineer has increased in the development of sports products, infrastructure and athlete performance. Sports technology and aerodynamics skills will lead to a lot of research, career growth and the entrepreneur.

The sports aerodynamics wind tunnel test section is long enough to visualize the flow begin the ball models, the rotating force strain gauge balance is fixed and the multi-bank manometer is customized for the ball pressure models.

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Kinovea-based Video Content Analysis of Elite Men's High Jump

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Abstract – *High jump is popular track and field sport event in international competitions. The ability of the athlete to jump and reach maximum height with respect to ground level is tested here. There are numerous analyses methods available to investigate the performance or to find the reasons behind one's successful jump. Video-based analysis is promising way to get deeper insight into many sports. To find and understand the relationship between performances of successful athletes, this research work performs a video analysis on three elite men's high jumpers who were the top three contestants of Rio 2016 summer Olympics. The video from YouTube was undertaken for the study. We used kinovea video motion analysis freeware to perform different kinds of studies. The analysis revealed many significant performance differences between the Gold, Silver and Bronze medalists in the final event which may be non-observable by bare vision or simply looking at the video. These minor differences are crucial in deciding the medal winning ability. The insight of our work will provide useful technical guidelines for the new high jump practitioners and coaches.*

Key Words: Video analysis, Kinovea, High jump, Performance analysis, fosbury, winning differences.

1. INTRODUCTION

With the introduction of new software and systems, the analysis of a sport or game has become common to get more knowledge about it. The knowledge gained will be helpful for athletes, teams and coaches to train in a systematic way. High jump is less video-analysed track and field event as compared to other events. Getting in-depth information about this sport will pave way for new comers to get trained without complexity and fear. Different styles of jump were practiced in olden days and Fosbury technique of 1960s is consistently followed till now. The high jump can be sub divided into three phases: approach, take-off and bar clearance or flight [2]. Many studies had earlier quantified high jump in any one or combination of these jump phases.

1.1 Related Works

Several works from literature were found showing the possibility of high jump sport analysis with video as a medium and are briefed in this sub section.

Video is used as a feedback method in [1] to analyze the high jump performance. Performance of players with and without vision or visual feedback is applied here to test their performance. Statistical analysis was performed to find the relationship between a player who had video feedback and who has not. Group of players who had visual feedback had outperformed the players without visual feedback. Also the possibility of self motivation of athletes from video is discussed here.

The biomechanical analysis of the world championship high jump was studied in [2]. The dependency of centre of mass of the high jumpers depending on different kinematics variables during the takeoff is studied. Centre of mass and velocity together determining the height of the flight was shown. They used three cameras to quantify the centre of mass locations of athletes. 8 best finalists were analyzed in this study with the height of their centre of mass during the last two contact were plotted. The physical capacities of individual player, the vertical velocity and height of the centre of mass at the end of take-off phase together determine the height of the flight.

The author of [3] proposed 3D biomechanical analysis of women's high jump techniques. The purpose of this study is to compare the performance of women participants with that of the elite level. Three digital video cameras were used to capture the 18 body anatomical parts via jumping video of women. The Kinematic parameters of the last two strides, the takeoff and the bar clearance were extracted for the analysis through software. Their results indicated kinematics parameters of the approach such as horizontal velocity stride length, angle, height of the body centre of mass being similar for some athletes and poor transformation of horizontal approach velocity to vertical takeoff velocity was observed.

An image-based and video-based analysis was performed on east African high jumpers as compared to the Olympic medalists. To check the validity and reliability of the claim of East African high jumpers jumping higher than Olympic medalist were investigated by [4] and found the claim to be false and also indicated that these novices can jump up to 135% of their height showing the ability of them participating in Olympics. The centre of mass height during the jump is calculated by [5] and the height of the jump is dependent on centre of mass, takeoff velocity and the takeoff angle. The high jump Kinematic parameters and its variability in longitudinal follow-up are analyzed in the paper [6].

Six competitions were video recorded using two digital cameras. For the purpose of kinematics analysis, it is necessary to take into account the subject's body height and body weight and with regard to the height of the jump. Video recordings of 92 high jumpers for 48 kinematics characteristics were analyzed by [7]. They used fuzzy neural network to develop an interactive system based on the analysis of kinematics characteristics of high jump. All stages of high jump are analyzed in detail and also improve the technique through the targeted correction of specific motions and achieve the optimal combination of kinematic values for the best possible result.

The relationship between the running speed and the radius of the curve was investigated by [8]. Relationship between the final directions of the paths of the centre of gravity and the footprints were made. The use of the takeoff leg during the elite high jump is analyzed in [9]. The purpose of this study was to evaluate kinematics and kinetics of jumpers. They used 19 infrared cameras and ground reaction forces to analyze the performance of elite high jumpers. The authors of [10] founded effects of initial conditions and take off technique on running jump for height and distance. National level analysis during the take off phase in fast Fosbury flop high jump technique is analyzed by [11] with respect to biomechanical characteristics of centre of mass height. The takeoff phase in high jump was analyzed by [12] in terms of biomechanical of kinematic parameters.

1.2 Rio 2016 Men's High Jump Finals

The elite men high jumpers from different countries were participated in the final event of Rio 2016 Olympics. The event had 15 participants initially and reduced to final three contestants. Their details, trail ranges and final achieved heights are shown in the Table -1 for reference.

Table -1: Summary of Medalists

Athlete Name / Country	Range of Height of Trials in Meters							Final Height & Medals Secured
	2.20	2.25	2.29	2.33	2.36	2.38	2.40	
Derek Drouin (Canada)	o	o	o	o	o	**o**	x	2.38 (Gold)
Mutaz Essa Barshim (Qatar)	o	o	o	o	**o**	xxx	NA	2.36 (Silver)
Bohdan Bondarenko (Ukraine)	-	o	-	**o**	-	xx-	x	2.33 (Bronze)

o = Height cleared, **x** = Height failed, **–** = Height passed, NA = Not Available

The video from YouTube is 12 minutes and 48 seconds long, showing the three toppers performing several times followed by slow motion video of the same performance after each trial.

1.3 Motion Analysis Using Kinovea

Kinovea is a popular video/motion analysis tool frequently used to study the kinematic and biomechanical characteristics of different sport activities. Recently the use of kinovea in sports and games applications has increased due to the validity, reliability and feasibility that it provides. Works related to measure vertical jumping height and tracking of leg's key points while jumping was already successfully carried out. A relative angle of drop Jump movement is analyzed using kinovea by [13]. The study revealed that kinovea is more reliable as compared to a 3D motion analysis system. Extensive study was made by [14] on validity, reliability and usefulness of smartphone and kinovea motion analysis software combination for direct measurement of vertical jump height as compared to costlier motion analysis system. This work uses facilities of kinovea depending on the nature of video shot during the event.

2. VIDEO ANALYSIS

The video was downloaded from YouTube and is of 1080p quality. The camera positions changes from athlete to athlete and with varying zoom level. The nature of obtained video does not allow us to measure all angle variations of body parts since it needs the camera to be in a fixed place and at right angles to object under study. So we take angle measurements only on body with respect to ground level and perform frame rate/ duration measurements. This section further elaborates on how the analysis was performed.

2.1 Dataset Creation

Firstly, the whole video was split into 32 small portions of variable duration videos. These videos contain the performance of all three finalists having normal speed and slow motion videos. Secondly, we created a dataset of 18 normal speed videos and 14 slow motion videos for the purpose of comparison and analysis. Thirdly, we noted the starting time, duration and frame numbers of each small video as shown in the Table -2. As the videos are obtained from a public web source, we cannot demand all the athletes having equal proportion of video duration. Hence, we used only small videos that were very useful to get some useful information and interpret the meaning of the content. All other portions of this dataset are ignored.

2.2 Video Comparison

From the dataset created, we extracted key frames with crucial measurements and compared the performance of three contestants by further simplifying the analysis via sub-division of the videos into three phases: approach, take-off and flight. Several parameters were extracted in all the three phases. Some of the examples include body inclination with respect to ground, number of running steps, running type, hand movement during running, hand position, angle measurements on CM (Centre of Mass) point and knee, jump position, flight details and timing details.

Table -2: Details of Dataset

Athlete Name / Country	Video Clip Type	Time & Frame Details	Range of Height of Trials in Meters						
			2.20	**2.25**	**2.29**	**2.33**	**2.36**	**2.38**	**2.40**
Derek Drouin (Canada)	Normal	Start Time	1:15:11	2:43:44	4:10:92	5:20:64	6:17:64	7:44:32	11:11:36
		Duration/ No. of Frames	7:40/ 186	6:00/ 151	6:40/ 161	6:56/ 165	6:40/ 161	6:96/ 175	7:00/ 176
	Slow Motion	Start Time	1:30:92	2:55:28	4:24:52	5:32:44	6:37:96	8:08:96	-
		Duration/ No. of Frames	7:07/ 177	6:44/ 162	5:20/ 131	6:04/ 152	5:84/ 147	7:58/ 190	-
Mutaz Essa Barshim (Qatar)	Normal	Start Time	1:43:32	3:24:76	4:38:32	5:45:84	6:51:88	8:35:08 & 8:48:16	-
		Duration/ No. of Frames	2:92/ 74	6:04/ 152	2:68/ 68	5:28/ 133	4:52/ 114	4:96/ 125 & 4:88/ 123	-
	Slow Motion	Start Time	2:00:20	3:36:68	-	6:01:40	7:08:64	9:11:72 & 9:19:20	-
		Duration/ No. of Frames	5:12/ 129	5:84/ 147	-	3:92/ 99	5:68/ 143	3:96/ 100 & 10:36/ 260	-
Bohdan Bondarenko (Ukraine)	Normal	Start Time	-	2:08:72	-	4:50:80	-	7:29:80	10:35:16
		Duration/ No. of Frames	-	6:08/ 153	-	5:77/ 145	-	5:24/ 132	4:88/ 123
	Slow Motion	Start Time	-	2:19:96	-	5:04:64	-	-	-
		Duration/ No. of Frames	-	3:80/ 96	-	3:54/ 89	-	-	-

2.2.1 Approach Phase

The videos of three players are synchronized so that we got a simultaneous time of approach phase. This phase has running and the lifting point with one leg. We observed the approach angle, number of steps of running before jumping, the running type and hand movement during this phase. Fig -1 shows the readings of approach body angle.

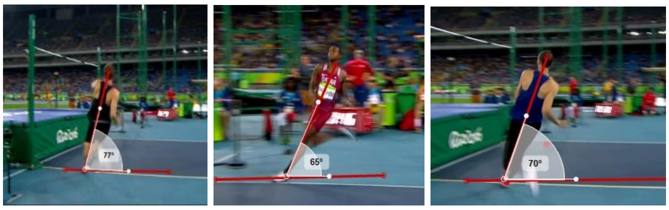


Fig -1: Approach Body Angles

We observed the unique running style of gold medal winner, having a flying type of running during the stride period. Also his hands were behind his body to create enough pace of his body before jumping. The silver medalist on the other hand, used a very short step in the beginning and the end of the stride period. The comparison between the gold and bronze medalists was shown as a composite image in Fig -2 for understanding. Note that the fly type running found in gold medalist (Running athlete's image in the behind)

Fig -2: Composite Running Style Comparison

The height of the legs from ground while running is very high for gold medalist and very low for the bronze medalist. Furthermore, the enormous swing of the hand was noticed in the topper and these factors together may contribute to his power to cross the bar in a smooth and curved position during the last phase of the jump.

Table -3 lists some important recordings during this analysis.

Table -3: Approach Quantities

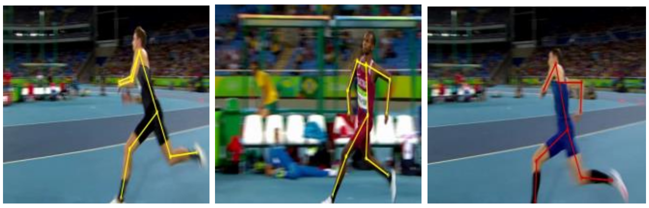
Quantities	Derek Drouin	Mutaz Essa Barshim	Bohdan Bondarenko
Approach Angle	77°	65°	70°
Running Type	3 to 5 short steps initially & unique Fly Running	4 short steps- (Includes one short step in start and end)	3 to 4 short steps and then normal
Hand Movement	For short instance, both hands behind the body	Normal (Alternate hands w.r.to legs)	Normal (Alternate hands w.r.to legs)

The number of steps was quantified for available dataset of different heights of jumping. Table -4 shows the comparison of stride length in terms of number of steps observed from the slow motion videos of the dataset.

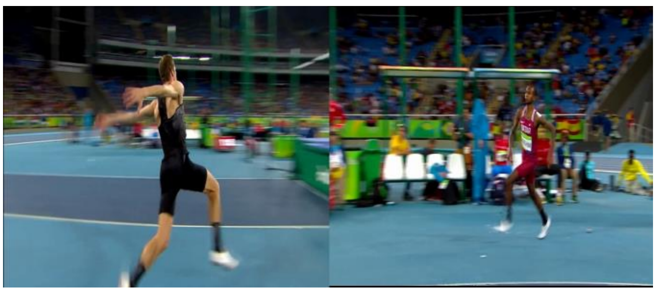
Table -4: Number of Running Steps

Trials of Different Heights	Derek Drouin	Mutaz Essa Barshim	Bohdan Bondarenko
1	11	-	-
2	12	14	15
3	12	-	-
4	13	14	16
5	12	12	-
6	14	13	13
7	14	13	14

The run type and the hand position of different athlete are also shown in Fig -3 (a) and (b) respectively.



(a) Run Type (Gold, Silver & Bronze Medallists in Order)



(b) Hand Positions (Gold & Silver Medallists)

Fig -3: Running Style Comparison

2.2.2 Take-off Phase

In this phase, the body position near the bar, hand position reaching towards bar, Angles of Centre of Mass (CM) and knee were analyzed. Table -5 summarizes these findings.

Table -5: Number of Running Steps

Quantities		Derek Drouin	Mutaz Essa Barshim	Bohdan Bondarenko
Body position near bar/ Reaching Hand		Left side/ Left	Right Side/ Right	Left side/ Left
Hand Position type		Other hand Bended	Other Hand Straight	Both Hands Reaching
Angles	∠CM	148°	160°	163°
	∠Knee	156°	150°	116°

Fig -4 shows the angle variations and positions of all the athletes.

Fig -4: Take-off Positions and Angles

2.2.3 Flight Phase

This is the most important phase that decides the medals. The other two phases of high jump accumulates here to perform and cross the bar. In the analysis, we found many crucial parameters for the successful high jump. The body shape features were noted and found the curved body position for the gold medallist as against flat body for both silver and bronze medallists. These body positions are not made consciously and it is the type of flight which is unique to each athlete. However, new trainees of high jumpers must take this factor importantly to succeed. Fig. -5 show the complete analysis.

Fig -5: Flight Body Shape

The height of the body from the bar is very important for each trial, as this will ensure the athletes to jump higher heights every time. In the performance comparison shown in Fig -6, it is very clear that the ability of maintaining higher height is depending on the talent level.

Fig -6: Body Height from Bar

The leg and hand positions of the athletes during flight were shown in Fig -7. Gold and silver medallists used scissor leg position but the bronze medallist used a combined leg position. And the hand position also played a vital role in gold medallist by bending the right hand (other than the reaching hand) during the flight.

Fig -7: Hand & Leg Positions During Flight

Then, we tracked one leg of all the players to understand about the flight type. For a better result, we should have tracked the centre of mass of the body. But due to the unavailability for a tracking marker, we tracked the individual shoe of the athletes and saw the variations as shown in the Fig -8.

Fig -8: Tracking Results

The tracking results show some interesting facts. The leg tracking of the players showed a smooth to irregular foot flight while crossing depending on the player's calibre. For example, the foot tracking of gold medallist is very smooth and perfectly curved. The silver medallist's was slightly curve with minor irregularities and the bronze medallist's was distorted. This together yields some understanding about the superior performance.

Finally, we also noted the typical time duration/ frame numbers of running to jump, jump to reaching bar and jump to crash land for all athletes to get a insight into total time taken by the athletes and was tabulated in the Table -6. The tabulated values are randomly taken from different heights.

Table -6: Start to End of Jumping Timing Details

Duration	All Measurement in (s:ms)/ No. of Frames		
	Derek Drouin	Mutaz Essa Barshim	Bohdan Bondarenko
Running to Jump	5:56/ 140	3.84/ 97	5:76/ 145
Jump to Reaching Bar	0:44/ 12	0:32/ 9	0:24/ 7
Jump to Crash Land	1:08/ 28	1:44/ 37	1:28/ 33

3. CONCLUSIONS

In this paper, we have performed kinovea-based video analysis on three top high jump performers during final game of Rio Olympics 2016. The analysis was made on three phases of high jump yielding the results to understand the medal winning abilities of these athletes. We performed angle measurements, side by side comparisons, height calculations, timing calculations etc., The purpose was not to quantify the parameters, but to understand the major and minor factors contributing the success. The bare vision capabilities of human cannot observe these parameters. Hence, these findings will be helpful for the coaches as well as the new high jump practitioners during practice.

This work suffers from few drawbacks. The video was taken from YouTube, which do not allow us to set the angle positions exactly from right angled view. The video seems to be moving in some places, which introduced some difficulty during analysis. We don't have facility to place markers in body parts of athletes to measure crucial parameters. A systematic analysis using own video setup and inclusion of professional high jumpers in real-time, would be a great advantage to get deeper understanding. The same analysis can also be extended to other sports and games as well.

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Study on Intelligent Data Algorithms Implemented in Wearable for Sports Applications

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Abstract: Technological transformation is unlocking new opportunities in wearable devices used in sports application. Nowadays training the sports involves the use of integrating smart sensors, cameras, internet of things and intelligent data algorithms into a device which is wearable making the players to achieve their maximum performance. These smart devices replace the coach and manage all aspects of technical training except for the physical training given by the real coach. This paper provides a comprehensive study on the intelligent data analysis made on the data acquired from sensors to give a meaningful sense to it. The smart training methods employed currently in various sports are identified and presented. The future directions in this area of research are also presented.

Keywords: Wearable devices, intelligent data algorithms, sensors, technical training, sports

1. Introduction

The technological boom has influenced in all areas of human life. Smart devices have changed the way of looking the world. Sports field is not an exception. Wearables take new dimension in monitoring sports activities of the player. These devices incorporated with smart algorithms help the player to understand his performance and help him to compete to next level. Due to developments in internet and cloud services the collected data from sensors can be worked in a detailed manner. Here clever algorithms can be applied which extracts the features, train the data set and can be tested to verify its accuracy. With these resources the devices now become smart Artificial Intelligent (AI) devices which will help the player to train himself and achieve better results. Section 2 discusses the role of wearables in smart training. Section 3 briefs the sensors that are commonly used in devices. Section 4 summarizes the intelligent approach used in the sports wearables and the results obtained. Section 5 lists the challenges faced and section 6 concludes with the limitations and identifies the scope of futureresearch.

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2.Wearables in SportsTraining

The role of coach for a player is very important. Unfortunately all aspirant players do not get their dream coach. Sometimes financial support also poses some problem. So, wearable technology could reduce this burden by providing solution to the above problem. Intelligent algorithms incorporated in these devices gives clues to the player so that he can understand his game profile and take necessary steps to correct and achieve histarget.

Two important sections in wearable device are,

1. Hardware
   a. Sensor selection
   b. Noise removal
   c. Communication to the decision making subsystem

2.Software which takes decision based on acquired signals.

The tasks performed during training require physical effort and it is a continuous process where the ultimate goal is to improve the perfection in the game played. The various stages involved in sports training are,

- Data acquisition
- Intelligent dataanalysis
- Assessment
- Targetrealization

The flow diagram for the sports training is shown in figure 1,

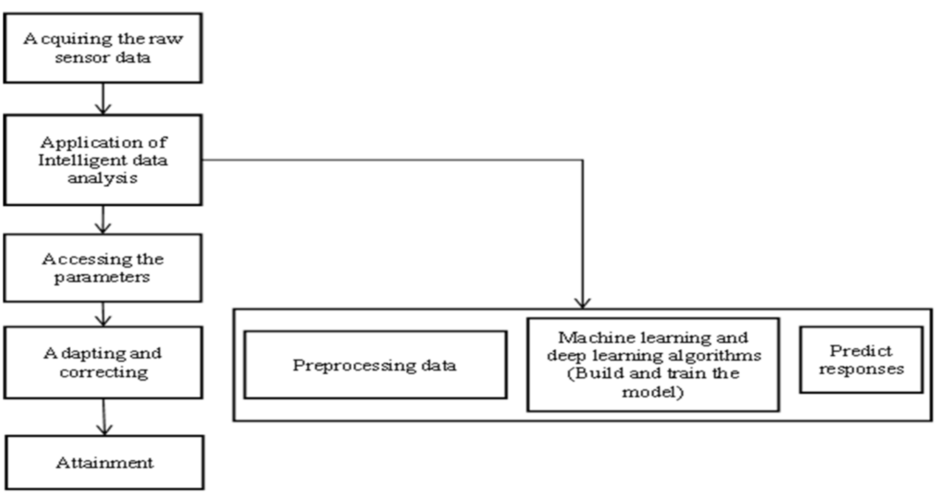

Figure 1. Flow diagram for sports training

3. Sensors

The important consideration for developing a wearable device is the selection of sensors. The sensors should be reliable, small in size, light in weight and durable. The data's from sensors can be used in activity recognition i.e. understand the body kinematics and movement parameters. The machine learning algorithms can be applied on the collected data's to bring out predictions. To get best results the user has to select the suitable algorithm to get the desired insight. The algorithm can be supervised or unsupervised. But all data processing algorithms cannot run on the device itself due to lack of its computational capacity, memory constraints and power back up. So with Bluetooth or wireless module the data's can be transported to a mobile or cloud services where intelligent algorithms can be performed to aid the player in decision making. This virtual coach assists the player in his training replacing the actual trainer. The various sensors deployed in sports wearables are inertial measurement unit which involves accelerometer, gyroscope and magnetometer, pressure sensor array, force sensor, motion sensor etc.

4. Intelligent data algorithms in sports

Intelligent data algorithms and data set can provide a method to analyze the performance parameter of an athlete and can improve his training plan to achieve the best results. Table 1 summarizes the information such as the name of the sport, the sensors used, the features detected, the goal, the classification algorithm and the accuracyobtained.

Table 1. Studies identified in sports wearable sensors with intelligent approach

Ref	Sport	Sensor	Features	Aim	Approach	Result
[1]	Basket ball	Motion sensor	Body acceleration , Gesture	Automatic recognition of basketball training type	Support Vector Machine (SVM)	99.5% accuracy with SVM algorithm or activity recognition
[2]	Basket ball	Accelerometer and Gyroscope	Arithmetic mean and Standard deviation	Classify the action of players	k-Nearest Neighbours (k-NN),Random Forests	Random Forests was more accurate than k-NN
[3]	Fitness	Multiple acceleration sensor on several parts of body/distributed across body	Mean, Maximum, Minimum, Range, Standard deviation, Root mean square	Examine the participant performance on collected data set from a smart wrist wearable device	k-NN, Linear SVM, Naïve Bayes with Gaussian kernel & Bernoulli(NB),SVM polynomial, Decision Tree (DT), Long Short-term Memory (LSTM)	LSTM is best with an accuracy of 92.5%

[4]	Fitness	Accelerometer and Gyroscope, Pulse rate sensor	Mean, Standard Deviation	Classify the indoor exercise activity such as biceps curl, Row, Pushup, Sit up, Squat and Triceps curl	k-NN,SVM, DT	95.3% accuracy for activity recognition and 99.4% for repetition count
[5]	Running	Wireless sensor network deployed in the area of training. MTS 400 sensor board, Crossbow MOTE2 IPR 2400	Mean, Standard Deviation	Develop a prototype to support athlete with ambient intelligent algorithms	k-NN, SVM, Spline Interpolation	Classification system achieves and accuracy of 80% in spline interpolation
[6]	Soccer	Data form video recordings	Mean, Maximum, Minimum, Standard deviation	Classify athlete position and predict the number of goals scored in the game	SVM, RF, Linear Regression (LR)	82% accuracy is achieved in RF and LR
[7]	Football	Data from data set at Tottenham Hotspur Football club	Maximum, Minimum	To predict the recovery time after injury without official diagnosis	SVM Radial basis function (RBF) kernel and polynomial kernel, Gaussian process with RBF and Laplace kernel, Artificial Neural Network (ANN)	Accuracy for SVM-98.43%, Gaussian process-97.4%,ANN –98%
[8]	Table Tennis	IMU sensor	Mean, SD, Skewness, Kurtosis	To detect and classify the stroke in table tennis	SVM linear, SVM RBF, RF, k-NN	SVM linear-95.6%, SVM RBF-96.7%, RF-95.7%, kNN-94.7%
[9]	Tennis	Video recordings	3 layer LSTM network	Classifies the activities in tennis shots	LSTM	81.23% to 88.16%
[10]	Volley ball	IMU, EMG sensors and video cameras	Mean, SD	Identifying and classifying the not allowed moves and providing feedback in training sessions	LSTM	F1 score of 0.74 for labels with 2 classes

[11]	Weight lifting	IMU	Mean, Variance, SD	Classifying the weight lifting exercises	SVM, Linear Discriminant Analysis (LDA)	94.36% accuracy in SVM
[12]	Cricket	Recorded videos	-	Develop AI training system to be used as a coach for trainees to become expert in batting, bowling and fielding	Fuzzy, ANN	Good classification accuracy
[13]	Cricket	Data form IPL matches	Mean, SD	To identify the best set of attributes in the player in the match played	SVM	81%
[14]	Golf	Strain gauge sensor, 3-axis accelerometer and 3-axis gyroscope	-	Investigate Golf swing data classification method	Convolutional Neural Network (CNN), SVM	95% of accuracy is achieved in deep CNN than SVM which is 86.8%

5. Challenges

Plenty of research is open in the field of sports training. Some of the challenges to be addressed are:

1. The authors have shown results conducted with certain method and approach and tabulated their findings. But they are not aware whether these methods will be adopted by all athletes over long term. So the researchers can share their views and results with the real world. Can interact with professional athlete and conduct more experiments and provide a wider scope to researchers.
2. Every player is unique, so integrating intelligent algorithms might not provide expected results for all as the body and thinking are different foreveryone.
3. All most all the design of wearables with intelligent algorithms is still in development phase, it means they are available in prototypes only. So with only proper validation these prototypes can be brought out as a commercialproduct.

6. Conclusion

This paper studies the various intelligent data algorithms proposed and implemented in the field of sports training. With technology the minute details of the game can be perceived. The accuracy and complexity of the models involved in this research vary due to the different classification problems that each model is tasked with. The study observes only few sports are concentrated and research should focus on the design and implementation of wearable in other sports also. Moreover the security issues in data handling also have to be considered.

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A Survey on Sports Video Annotation Frameworks

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Abstract. Video annotation technique delivers many additional video processing capabilities for several applications. Sports broadcast video content is unique in regard to wealth of information as compared to any other video. Sports video annotation is becoming popular among researchers in recent times because of wide range of applications and challenges it pose. The demand for optimized design of framework for sports video annotation is at peak. This paper surveys state-of-the-art in annotation framework design, particularly for sports applications and provides insight into future aspects. This survey may help researchers to further conceive and develop advanced universal frameworks applied to all sports.

Keywords. Sports video annotation, annotation framework design, annotation architecture, broadcasting video, Machine Learning,Neural Networks

1. Introduction

Several technological developments in recent past of video broadcasting and presentation have improved sports video broadcasting quality with significant increase in the number of subscribers. Apart from the conventional TV broadcasting, the boom in OTT platform, web-based (internet) telecasting, reduction in data cost and higher data rate led to a tremendous growth of sports entertainment industry in the recent times. Sports video annotation is regarded as an assisting mechanism in many sports video applications like analysis, retrieval, indexing, summarization[2], browsing/surfing, content mining, video skimming [11], providing supplementary information [10], generate metadata/metainfo for advanced techniques such as artificial intelligence and machine learning [11], video management and many more boundless areas [3,13].

The people in front of various devices watching the broadcast/telecast sports video outnumber the people watching it live on the stadium. So broadcasters have the responsibility to convince the needs of these viewers/consumers to commercially succeed and continuously entertain and retain them as long term subscribers. Annotation in sports video is crucial for broadcasters or even end-users to satisfy their commercial or personal needs respectively [1]. The upcoming sections are categorized as follows: Section 2 outlines the uses of video annotation in various sports video as a specific case.

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Section 3 analyzes various sports video annotation attributes found in literature. Section 4 deals with existing challenges and future aspects on this area. In section 5, we summarize this work and its importance in current research context.

2. Sports Video Annotation

Sports video annotation is still considered as hot research area among researchers due to its knowledge generating capabilities [14] and commercial value [11]. It conveys additional useful information for all kinds of videos [12]. However, the richness of content in sports video is completely different from other general videos. Furthermore, each sport video is diverse in nature, thus demanding different ways of approach in video annotation. For example, ball-only type of sport video annotation is inappropriate for racquet based sport [16].

Framework design of sports video semantic annotation is challenging, complex and very demanding [1,3]. Design of conventional or small scale framework for large scale dataset is becoming impractical [6]. The motive of video annotation and its framework is to relate the video features (low-level) and semantic labels (high-level) [3,13,14]. Moreover the framework should define semantic meaning of objects, events and context [8]. It implies scene interpretation at higher level and data acquisition. It is considered as the toughest task even for computer vision techniques [11,16].

2.1. Framework design/structure

The framework design falls into any one of two major categories. They are specific or generic. Specific frameworks are suitable for many sports videos and they concentrate more on sports/games related annotation tasks and generic frameworks are applied for several genres of videos with sports video as a subset. The Survey related to AVA (Automatic Video Annotation) is proposed by [13] and applicable to all general videos. The literature survey related to Sport video as specialization is carried out in this work.

2.1.1. Specific Framework

Many frameworks proposed in literature are available as sports specific and some of them can be extended to general video applications. This section lists all sport- specific video annotation frameworks and briefly discusses them. Changsheng Xu et al [1] Contributed framework for video summarization and retrieval of sports video. Here, two-level annotation scheme is used. First level gives the overall summary taken from webcasting text. And second level annotates every event of video employing semantics of text as well as video boundaries grabbed from alignment of text or video.

Mentzelopoulos et al [4] has provided a system for extracting shot boundaries using low-level feature video processing algorithms. Campos et al [5] proposed an automatic sports video annotation framework based on Bayesian reasoning framework aiming to annotate court sport videos at all cognitive levels with adaptability and event classification at any time with user request.

Assfalg et al [9] contributed semantic annotation system that utilizes visual cum graphical features on the video frames. Additionally, color histogram is used for object tagging. Xue et al [10] designed an AVA system for archival sports video. This work delivers rich metainfo of the videos archived.

Kolekar et al [11] labeled video clips by automatic segmentation of broadcast videos and framework provides answers of difficult queries related to video clips. Deng et al [16] proposed data analysis annotation framework. It is dedicated to racquet sports videos and has provision for tools to carry out interactive annotation. In addition, they used supporting computer vision algorithms.

2.1.2. Generic Framework

The generic frameworks in literature have potential to satisfy the requirements of sports video annotation. These frameworks are considered in this survey of sports applications, because of having provision to modify them for sport needs. Zhang et al [2] proposed a semi-supervised learning framework with six types of sports events for analysis. It uses labeled, unlabeled, small scale and large scale videos to train the model. Aote and Potnurwar [3] had undergone a novel approach to define a two- level keyframe extraction method for AVA.

Hwang et.al [6] attempted to provide deep insight from enormous video datasets available in internet to train. Getahun and Birara [8] used audio element of scenes to assist identification of object and event using high level architecture. Islam et al [14] highlighted the importance of distributed framework for AVA. The concept is spatio and spatio-temporal oriented that provides application based solution for users. Human action in sports is taken for their analysis. Huskey and Hill [15] facilitated dedicated video pane in video annotation interface with many functionalities.

3. Literature Survey

Various attributes of sports video annotation framework are listed in Table 1 with both specific and generic framework taken into consideration.

Table 1. Attributes of Sports Video Annotation Framework

Reference	Framework Type	Approach	Applications	Sports Use Cases	User/Personal Preference
[1]	Specific	Web Casting Text	Semantic annotation Indexing & Retrieval	Soccer, Basket ball and other sports/ games	Summary Creation
[2]	Generic	Semi-supervised Learning	Training for event detection and annotation	Basket ball	Search and browse Videos

[3]	Generic	Machine Learning	Shot detection, keyframe and feature extraction	Generally sports	None
[4]	Specific	Active region detection & extraction	Automatic Video segmentation for annotation	Football, Squash & Basketball	None
[5]	Specific	Anomaly Detection & Transfer Learning	Annotate court sports video	Tennis	Event Classification
[6]	Generic	Mapreduce training	annotation for large datasets	Basket ball (As framework input)	None
[7]	Generic	Convolutional Neural Network	Analysis and Management	General	None
[8]	Generic	Video Scenes & associated audio	Event and Object Identification	Basket ball (Shot & Scene Identification)	Video addition, threshold setting, result visualizing and XML or SRT file generation for annotation
[9]	Specific	Visual & graphical features using neural networks	annotate videos at different layers of semantic significance	Several sport videos & Studio/Interview shots	Retrieval of specific shots on demand
[10]	Specific	Computer Vision	archival sports video	Baseball	None
[11]	Specific	Event & Concept level	Semantic labeling	Soccer	Answers difficult queries
[14]	Generic	Spatial & Spatio-temporal	1.End-user distributed VA services 2.Developer algorithm services	Baseball (Pitch), Skate boarding & running	create new VA algorithms through VA & APIs
[16]	Specific	Data Analysis with CV Techniques	Multiple level video data annotations	Racquet sports	User event acquiring from videos & offers interactive tools

4. Future aspects

With the advent of advanced learning methods such as machine learning, computer vision and neural networks [3,7,16], the annotation task becomes easier. But, the existing data acquisition abilities suffer from limitations [16] and faces challenges [3]. The need for universal annotation framework for all sports is essential. Preference must be given to scalability, adaptability and applicability features of a framework.

5. Conclusion

This paper summarizes domain-specific and generic frameworks with application to sports video. The characteristics/attributes of frameworks related to sports video annotation are presented. Investigators, particularly in field of sports video annotation may find this work useful for their optimized framework design.

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"RELATIVE EFFECT OF ISOLATED AND COMBINED INTERVAL TRAINING AND CONTINUOUS RUNNING ON SELECTED ENDURANCE COMPONENTS AMONG STATE LEVEL FOOTBALL PLAYERS"*

BY

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Abstract

The purpose of the study was to find out the relative effect of isolated and combined interval training and continuous running on selected endurance components among state level football players. The study was formulated as a true random group design, consisting of a pre-test and post-test. Sixty state level football players from Tamilnadu, India were selected as subjects at random and their ages ranged from 18 to 25 years. The subjects (N=60) were randomly assigned to four equal groups of fifteen subjects each. Pre test was conducted for all the subjects on selected speed and endurance components. This initial test scores formed as pre test scores of the subjects. The groups were assigned as Experimental Group I, Experimental Group II, Experimental Group III and Control Group in an equivalent manner. Experimental Group I was exposed to interval training, Experimental Group II was exposed to continuous training, Experimental Group III was exposed to combined interval and continuous training and Control Group underwent no training. The duration of experimental period was 12 weeks. After the experimental treatment, all the sixty subjects were tested on their selected endurance components. This final test scores formed as post test scores of the subjects. The pre test and post test scores were subjected to statistical analysis using Analysis of Covariance (ANCOVA) to find out the significance among the mean differences, whenever the 'F' ratio for adjusted test was found to be significant, Scheffe's post hoc test was used. In all cases 0.05 level of significance was fixed to test hypotheses. The combined interval and continuous training group had shown better performance on endurance components among the state level football players than the interval training, continuous training and control groups.

Keywords: Interval Training, Continuous Training,

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Introduction

Interval training is a form of progressive conditioning in which the intensity of the activity, the duration of each set, the number of sets, the time or kind of rest periods between sets or the order of the sets are varied. The variables associated with interval training include the number of repetitions, the duration of effort, work intensity and duration of recovery (Dhayanithi, 1991). Continuous training means the trainee uses 60-80% of his maximum heart rate for at least 30-60 minutes at least four or five times a week. This method suits long distance runners as well as football players, because it means that their endurance levels will increase. It is the way which they would normally compete. It is a good way for an athlete to build up their cardio-vascular endurance levels. It also forms the basis for all other training methods both anaerobic and aerobic.

Methodology

The study was formulated as a true random group design, consisting of a pre-test and post-test. Sixty state level football players from Tamilnadu, India was selected as subjects at random and their ages ranged from 18 to 25 years. The subjects (N=60) were randomly assigned to four equal groups of fifteen subjects each. Pre test was conducted for all the subjects on selected endurance components. This initial test scores formed as pre test scores of the subjects. The groups were assigned as Experimental Group I, Experimental Group II, Experimental Group III and Control Group in an equivalent manner. Experimental Group I was exposed to interval training, Experimental Group II was exposed to continuous training, Experimental Group III was exposed to combined interval and continuous training and Control Group underwent no training. The duration of experimental period was 12 weeks. After the experimental treatment, all the sixty subjects were tested on their selected endurance components. This final test scores formed as post test scores of the subjects. The pre test and post test scores were subjected to statistical analysis using Analysis of Covariance (ANCOVA) to find out the significance among the mean differences, whenever the 'F' ratio for adjusted test was found to be significant, Scheffe's post hoc test was used. In all cases 0.05 level of significance was fixed to test hypotheses.

Results

TABLE I

COMPUTATION OF ANALYSIS OF COVARIANCE ON MUSCULAR ENDURANCE AND CARDIORESPIRATORY ENDURANCE

		ITG	CTG	CICTG	CG	SOV	Sum of Squares	df	Means Squares	F-ratio
Muscular Endurance	Pre-test Means	34.93	34.66	35.06	34.33	BG	4.717	3	1.572	0.826
						WG	106.533	56	1.902	
	Post-test Means	40.20	39.66	42.53	35.06	BG	439.533	3	146.511	67.031*
						WG	122.400	56	2.186	

	Adjusted Means	40.22	39.65	42.56	35.02	**BG**	431.245	3	143.748	65.235*
						WG	121.194	55	2.204	
Cardio Respiratory Endurance	**Pre-Test Means**	1547.33	1535.33	1527.06	1536.00	**BG**	3119.133	3	1039.71	1.588
						WG	36673.60	56	654.886	
	Post-Test Means	1684.33	1700.33	1737.00	1539.66	**BG**	337713.333	3	112571.111	216.781*
						WG	29080.00	56	519.286	
	Adjusted Means	1685.44	1700.22	1736.04	1539.62	**BG**	335338.51	3	111779.505	214.245*
						WG	28695.45	55	521.736	

Muscular endurance obtained F-ratio for the post-test was 67.031 and the table F-ratio was 2.76. Hence the post-test mean F-ratio was significant at 0.05 level of confidence for the degree of freedom 3 and 56. The obtained F-ratio for the adjusted post-test means was 235 and the table F-ratio was 2.77. Hence the adjusted post-test mean F-ratio was significant at 0.05 level of confidence for the degree of freedom 3 and 55. This proved that there was a significant difference among the means due to the experimental trainings on muscular endurance.

Cardio respiratory endurance obtained F-ratio for the post-test was 216.781 and the table F-ratio was 2.76. Hence the post-test mean F-ratio was significant at 0.05 level of confidence for the degree of freedom 3 and 56. The obtained F-ratio for the adjusted post-test means was 214.245 and the table F-ratio was 2.77. Hence the adjusted post-test mean F-ratio was significant at 0.05 level of confidence for the degree of freedom 3 and 55. This proved that there was a significant difference among the means due to the experimental trainings on Cardio respiratory endurance.

Since significant differences were recorded, the results were subjected to post hoc analysis using Scheffe"s post hoc test. The results were presented in table 2.

TABLE II

THE SCHEFFE'S TEST FOR THE DIFFERENCES BETWEEN THE ADJUSTED POST-TEST MEANS ON MUSCULAR ENDURANCE AND CARDIO RESPIRATORY ENDURANCE

	Adjusted Post-Test Means				**Mean Difference**	**Confidence Interval**
	ITG	**CTG**	**CICTG**	**CG**		
MUSCULAR ENDU	40.22	39.65	---	---	0.57	**1.56**
	40.22	---	**42.56**	---	2.34*	
	40.22	---	---	**35.02**	5.20*	

	---	**39.65**	**42.56**	---	2.91*	
	---	**39.65**	---	**35.02**	4.63*	
	---	---	**42.56**	**35.02**	7.54*	
CARDIO RESPIRATORY ENDURANCE	1685.44	1700.22	---	---	14.78	**24.04**
	1685.44	---	**1736.04**	---	50.60*	
	1685.44	---	---	**1539.62**	145.82*	
	---	**1700.22**	**1736.04**	---	35.82*	
	---	**1700.22**	---	**1539.62**	160.60*	
	---	---	**1736.04**	**1539.62**	196.42*	

The combined interval and continuous training group had shown better performance on endurance components among the state level football players than the interval training, continuous training and control groups.

Conclusions

1. The interval training group had shown significant improvement in all the selected endurance components among state level football players after undergoing interval training group for a period of twelve weeks.
2. The continuous training group had shown significant improvement in all the selected endurance components among state level football players after undergoing the continuous training group for a period of twelve weeks.
3. The combined interval and continuous training group had shown better performance on endurance components among the state level football players than the interval, continuous training and control groups.

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This is to certify that

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for the paper entitled

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EFFICACY OF COMBINATION OF NATIONAL CADETS CORPS TRAINING AND PLYOMETRIC TRAINING ON SELECTED PHYSIOLOGICAL VARIABLES AMONG COLLEGE NCC STUDENTS

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ABSTRACT

The purpose of the study was to find out the efficacy of combination of National Cadets Corps training and plyometric training on selected physiological variables among College NCC students. To achieve this purpose, thirty male College NCC students were selected as subjects, their aged between 18 to 25 years; they are studying in the various college of Chennai, Tamilnadu. The selected subjects were divided into two equal groups of fifteen subjects each, namely Combination of National Cadets Corps training and plyometric training group and control group. The experimental group trained for three alternative days in a week for eight weeks with three sets per exercise per session at 60 to 80% with a progressive increase in load with the number of weeks. Physiological variables such as Breath holding time and Vital capacity were selected as criterion variables and they were tested by using Stop watch and Wet spirometer respectively. ANCOVA was used to find out the significant difference if any between the groups. The results of the study showed that there was a significant improvement on selected physiological variables such as breath holding time and vital capacity due to eight weeks of combination of National Cadets Corps training and plyometric training as compared to control group.

KEY WORDS: NATIONAL CADETS CORPS TRAINING, PLYOMETRIC TRAINING, BREATH HOLDING TIME AND VITAL CAPACITY.

INTRODUCTION

The youth of the country is a national asset and its development is a task of great significance and importance. The NCC has the expertise and built-in infrastructure to fulfill this mandate. Over the years NCC has contributed towards achieving this goal in an effective and meaningful manner. The National Cadet Corps (NCC) holds a golden key for all-round growth and transformation of our youth. What began in the year 1917, as the University Corps, after many changes and overhauls through the years, has come to be known as the National Cadet Corps (NCC) since November 1948. Today, with nearly 14 lakh cadets, both boys and girls, from over 13000 colleges and schools inclusive of those in remote and far flung areas, on its roll, the NCC is projected as the largest disciplined, uniformed youth organization in the world.

Plyometric training can take many forms, including jump training for the lower extremities and medicine ball exercises for the upper extremities. All the exercises are progressive in nature, with a range of low to high intensity in each type of exercises. Plyometric training is used for the lower body, upper body and core to enhance speed of movement in more specific skills. Plyometric training helps athletes learn greater balance, co-ordination, quickness, agility, speed and power.

Plyometric movements are performed in a wide spectrum of sports. In establishing the aim of plyometric training we must proceed from the definition of the general concept of training. We have stated that plyometric training is a means of achieving higher standard performances in athletics.

METHODLOGY

The purpose of the study was to find out the efficacy of combination of National Cadets Corps training and plyometric training on selected physiological variables among College NCC students. To achieve this purpose, thirty male College NCC students were selected as subjects, their aged between 18 to 25 years, they are studying in the various college of Chennai, Tamilnadu. The selected subjects were divided into two equal groups of fifteen subjects each, namely combination of National Cadets Corps training and plyometric training group and control group.

The selected subjects had undergone the Combination of National Cadets Corps training and plyometric training for eight weeks, with three days per week in alternate days. After 10 to 15 minutes of warm-up the subjects underwent National Cadets Corps training followed by plyometric training programme and the subjects performed Mark time march- 30beats/ 30 sec, Slow march- 70 paces/mints, Quick march- 120 paces/mints, Double march- 180 paces/mints for four weeks after that they performed four weeks of plyometric exercises 6 to 12 repetitions of plyometric exercises namely hopping, bounding, hurdles exercises, depth jumps, medicine ball throws, with a recovery distance of 20 to 40 meters or one to three minutes between repetitions. The control group did not participate in any specialized training during the period of study.

EXPERIMENTAL DESIGN AND STATISTICAL PROCEDURE

The experimental design used for the present investigation was random group design involving 30 subjects for training effect. Analysis of Covariance (ANCOVA) was used as a statistical technique to determine the significant difference, if any, existing between pretest and posttest data on selected dependent variables separately and presented in Table-I.

EXPERIMENTAL DESIGN AND ANALYSIS OF DATA

The experimental design used for the present investigation was random group design involving 30 subjects for training effect. Analysis of Covariance (ANCOVA) was used as a statistical technique to determine the significant difference, if any, existing between pretest and posttest data on selected dependent variables separately and presented in Table- I

TABLE – I

Variables	Test		Combination of NCC training and plyometric training Group	Control Group	Source of Variance	SS	df	Mean Square	'F' Ratio
Breath Holding Time	Pre test	Mean	40.13	40.96	Between	0.833	1	0.833	0.742
		S.D	4.191	2.95	Within	110.133	28	3.96	
	Post test	Mean	44.65	40.82	Between	19.20	1	19.20	22.049
		S.D	2.65	2.95	Within	123.6	28	4.86	
	Adjusted Post test	Mean	44.68	40.96	Between	26.72	1	26.72	27.64*
					Within	270.3	27	10.03	
Vital Capacity	Pre test	Mean	2408	2428	Between	3.33	1	3.33	1.33
		S.D	307.68	302.1	Within	648.53	28	23.162	
	Post test	Mean	2854	2434	Between	24.30	1	24.30	177.15
		S.D	260.90	305.54	Within	335.07	28	335.07	
	Adjusted Post test	Mean	2858	2432	Between	31.905	1	31.905	179.4*
					Within	708.53	27	40.02	

DISCUSSION

The result of the study indicates that the combination of National Cadets Corps training and plyometric training group had significantly improved the selected dependent variables namely breath holding time and vital capacity. However, control group did not show any improvement on the selected variables as it was not involved in any of the specific training means. The result of the study in consonance with the findings of plyometric training has produced significant improvement on breath holding time and vital capacity.

CONCLUSION

Based on the results of the study, it was concluded that

- There was a significance difference among combination of National Cadets Corps training and Plyometric training group and control group.

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- The results of the study revealed that there was a significant improvement on selected physiological variables such as breath holding time and vital capacity due to eight weeks of Combination of breath holding time and vital capacity.

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"EFFECT OF GAME SPECIFIC TRAINING ON SELECTED PHYSICAL AND PHYSIOLOGICAL VARIABLES AMONG COLLEGE LEVEL FOOTBALL PLAYERS"

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ABSTRACT

The purpose of the study was to determine the Effect of Game Specific Training on Selected Physical and Physiological variables among college level Football Players. To achieve this purpose, thirty men players were randomly selected from Chennai - Tamilnadu. The age of the subjects were ranged from 17 to 23 years. The selected subjects were divided into two groups such as Group – A was Experimental Group and Group – B was the Control Group. Each group consisting of 15 subjects. The experimental group underwent game specific training. The following criterion variables were selected for the physical variables namely, Speed, Agility and Leg Explosive Power and for the Physiological Variables such as Breadth Holding Time and Resting Heart Rate. The training period was 12 weeks except Saturdays and Sundays in every week. Data were collected from each subject before and after the 12 weeks of specific training. The collected data were statistically analyzed by using "t" Ratio. It was found that there is significant improvement in Speed, Agility and Leg explosive power due to the treatment of specific training. It was also found that there is significant improvement in Breath Holding Time and Resting Heart Rate due to the treatment of specific training.

Keywords: Game Specific Training, Physical Variables and Physiological Variables

INTRODUCTION: A sport is an organized, competitive, entertaining and skilful physical activity requiring commitment, strategy and fair play in which a winner can be defined by objective means. It is governed by a set of rules or customs. In sports the key factors are the physical capabilities and skills of the competitor when determining the outcome (winning or losing). Sports are most often played just for fun or for the simple fact that people need exercise to stay in good physical condition. However, professional sport is a major source of entertainment. While practices may vary, sports participants are expected to display good sportsmanship and observe standards of conduct such as being respectful of opponents and officials and congratulating the winner when losing (Douglas Harper, 2008).

TRAINING

Training is an educational process. People can learn new informations, re - learn and reinforce existing knowledge and skills, and most importantly have time to think and consider what new options can help them improve their effectiveness at work. Effective trainings convey relevant and useful information that inform participants and develop skills and behaviors that can be transferred back to the work place. The word 'Training' has been a part of human language since ancient times. It denotes the process of preparation for some task. This process invariably extends to a number of days and even months and years. The term 'Training' is widely used in sports. There is, however, some disagreement among sports coaches and also among sports scientists regarding the exact meaning of this word. Some experts, especially belonging to sports medicine, understand sport straining as basically doing physical exercises.

III. METHODOLOGY

The purpose of the present study was to determine the Effect of Specific Training on Selected Physical and Physiological Variables among College Level Men Football Players. To achieve this, thirty Men Football Players were randomly selected from Chennai Tamilnadu. The age of the subject ranged from 17 to23 years. The selected subjects were divided into two equal groups such as group - Group A was Experimental Group and Group - B was Control Group. Each group consisting of 15subjects. The Experimental Group underwent Game Specific Training. The following criterion variables were selected for the Physical Variables namely Speed, Agility and Leg Explosive Power and for the Physiological Variables such as Breathe Holding Time and Resting Heart Rate. The training period was for 12 weeks except on Saturdays and Sundays.

STATISTICAL TECHNIQUE

The following statistical procedure was employed to estimate the Effect of Specific Training on Selected Physical and Physiological Variables among College Level Men Football Players, ‘T’ Ratio was calculated to find out the significant of the difference between the mean of Pre and Post - Test of the groups.

RESULTS AND DISCUSSION

The data obtained on speed as a result of specific training were analyzed using the “t” Ratio and are presented in Table 2.

Table - 2

Table showing the Mean Difference, Standard Deviation and “T” Value of Control Group and Experimental Group on Speed

Variables	Group Name	Mean		SD		SD Error	‘T’ Ratio	Table Value
		Pre	Post	Pre	Post			
Speed	Control	6.85	6.86	0.14	0.17	0.04	0.98	2.15
	Experimental	6.83	6.42	0.13	0.19	0.04	9.02*	

Significance at 0.05 Level of Confidence

The Table 2 shows that the mean values of Pre - Test and Post - Test of Control Group in Speed were 6.85 and 6.86 respectively. The obtained ‘T’ ratio was 0.98 since the obtained ‘T’ ratio was less than the required table value is 2.15 for the significant at 0.05 levels with 14 degrees of freedom. It was found to be statistically insignificant. The mean values of Pre – Test and Post – Post of Experiment Groups in Speed were 6.83 and 6.42 respectively.

The obtained „t‟ ratio was 9.02 since the obtained ‘t’ ratio was greater than the required table value of 2.15 for significance at 0.05 level with 14 degrees of freedom it was found to be statistically significant.The result of the study showed that there was a significant difference between control group and experimental group in speed. It may be concluded from the result of the study that experimental group improved in speed due to eight weeks of specific training.

The data obtained on agility as a result of game specific training was analyzed using the 't' ratio and are presented in table 3.

Table - 3
Table showing the Mean Difference, Standard Deviation and "T" value of Control Group and Experimental Group on Agility

Variables	Group Name	Mean		SD		SD Error	'T' Ratio	Table Value
		Pre	Post	Pre	Post			
Agility	Control	7.81	7.80	0.16	0.15	0.04	0.42	2.15
	Experimental	7.78	7.29	0.24	0.31	0.08	5.87*	

Significance at .05 level of Confidence

The Table 3 shows that the mean values of Pre - Test and Post - Test of Control Group in Agility were 7.81and 7.80 respectively. The obtained "t" ratio was 0.42 since the obtained "t" ratio was less than the required table 2.15 for the significant at 0.05 levels with 14 degrees of freedom. It was found to be statistically insignificant. The mean values of pre-test and post-test of experimental groups in agility were 7.78 and 7.29
Respectively.
The obtained "t" ratio was 5.86 sine the obtained "t" ratio was greater than the required table value of 2.15 for significance at 0.05 level with 14 degrees of freedom it was found to be statistically significant. The result of the study showed that there was a significant difference between Control Group and Experimental Group in Agility. It may be concluded from the result of the study that Experimental Group improved in agility due to12 weeks of specific training.

The data obtained on leg explosive power as a result of specific training were analyzed using the "t" ratio and are presented in table -IV.

Table - 4
Table Showing the Mean Difference, Standard Deviation and 'T' Value of Control Group and Experimental Group on Leg Explosive Power

Variables	Group Name	Mean		SD		SD Error	'T' Ratio	Table Value
		Pre	Post	Pre	Post			
Leg Explosive Power	Control	2.41	2.51	0.15	0.22	0.04	0.73	
	Experimental	2.38	2.69	0.10	0.17	0.03	3.06	2.15

Significance at .05 level of Confidence

The table IV shows that the mean values of Pre - Test and Post - Test of Control group in Leg Explosive Power were 2.41 and 2.51 respectively. The obtained "t" ratio was 0.73. Since the obtained "t" ratio was less than the required table 2.15 for the significant at 0.05 levels with 14 degrees of freedom. It was found to be statistically insignificant. The mean values of Pre - Test and Post - Test of Experimental Groups in Leg Explosive Power were 2.38 and 2.69 respectively.

The obtained "t" ratio was 3.06 since the obtained "t" ratio was greater than the required table value of 2.15 for significance at 0.05 level with 14 degrees of freedom it was found to be statistically significant .The result of the study showed that there was significant difference between Control Group and Experimental Group in Leg Explosive Power.

The data obtained on Breath holding Time as a result of specific training were analyzed using the 't' ratio and are presented in table -V.

Table - 5

Table Showing the Mean Difference, Standard Deviation and 'T' Value of Control Group and Experimental Group on Breath Holding Time

Variables	Group Name	Mean		SD		SD Error	'T' Ratio	Table Value
		Pre	Post	Pre	Post			
Breath Holding Time	Control	45.37	45.38	3.05	3.05	0.79	0.07	2.15
	Experimental	45.45	48.12	3.35	2.99	0.77	2.49*	

Significance at .05 level of Confidence

The table V shows that the mean values of Pre - Test and Post - Test of Control group in Breath Holding Time were 45.37 and 45.38 respectively. The obtained "t" ratio was 0.07. Since the obtained "t" ratio was less than the required table 2.15 for the significant at 0.05 levels with 14 degrees of freedom. It was found to be statistically insignificant. The mean values of Pre - Test and Post - Test of Experimental Groups in Breath Holding Time were 45.45 and 48.12 respectively.

The obtained "t" ratio was 2.49 since the obtained 't' ratio was greater than the required table value of 2.15for significance at 0.05 level With 14 degrees of freedom it was found to be statistically significant .The result of the study showed that there was a significant difference between Control Group and Experimental Group in Breath Holding Time .

The data obtained on resting heart rate as a result of specific training were analyzed using the 'T' ratio and are presented in table 6.

Table - 6

Table Showing the Mean Difference, Standard Deviation and 'T' Value of Control Group and Experimental Group on Resting Heart Rate

Variables	Group Name	Mean		SD		SD Error	'T' Ratio	Table Value
		Pre	Post	Pre	Post			
Resting Heart Rate	Control	75.60	75.27	2.87	2.81	0.73	0.81	**2.15**
	Experimental	74.80	72.67	2.46	2.44	0.63	2.96*	

Significance at .05 level of Confidence

The table VI shows that the mean values of Pre - Test and Post - Test of Control Group in Resting Heart Rate were 75.60 and 75.27 respectively. The obtained 't' ratio was 0.81 since the obtained "t" ratio was less than the required table 2.15 for the significant at 0.05 levels with 14 degrees of freedom. It was found to be statistically insignificant. The mean values of Pre - Test and Post - Test of Experimental Group in Resting Heart Rate were 74.80 and 72.67 respectively.

The obtained "t" ratio was 2.96 since the obtained "t" ratio was greater than the required table value of 2.15 for significance at 0.05 level With 14 degrees of freedom it was found to be statistically significant. The result of the study showed that there was a significant difference between Control Group and Experimental Group in Resting Heart Rate in. It may be concluded from the result of the study that Experimental Group improved in Resting Heart rate due to 12 weeks of specific training.

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DISCUSSIONS ON FINDINGS

The result of the study indicates that the Experimental Group namely Specific training group had significantly improved the selected Physical & Physiological Variables, when compared to the Control Group. It is also found that the improvement caused due to Game Specific training when compared to the Control Group.

CONCLUSIONS

1. The results of the study showed that there were significant improvements in Physical Variables on Speed, Agility and Leg Explosive Power after 12 weeks of Specific Training among College Men Football Players.
2. The results of the study showed that there were significant improvements in Physiological Variables on Breath Holding Time and Resting Heart Rate after 12 weeks of specific training among College Men Football Players.

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CHANGES ON SELECTED MOTOR FITNESS COMPONENTS IN RESPONSE TO COMBINATION OF AEROBIC AND ANAEROBIC TRAINING AMONG COLLEGE NCC STUDENTS

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ABSTRACT

The purpose of the study was to find out the changes on selected motor fitness components in response to combination of aerobic and anaerobic training among College NCC students. To achieve this purpose, thirty male players were selected as subjects, their aged between 18 to 25 years, they are studying in the various college of Chennai, Tamilnadu. The selected subjects were divided into two equal groups of fifteen subjects each, namely combination of aerobic and anaerobic training group and control group. The aerobic and anaerobic training group trained for combination of aerobic and anaerobic exercises three sets per exercise per session at 60 to 80% with a progressive increase in load with the number of weeks. Strength endurance and agility were selected as criterion variables and they were tested by using sit-ups and shuttle run respectively. ANCOVA was used to find out the significant difference if any between the groups. The results of the study showed that there was a significant difference on strength endurance and agility between combination of aerobic and anaerobic training group and control group.

KEY WORDS: AEROBIC TRAINING, ANAEROBIC TRAINING, MOTOR FITNESS, STRENGTH ENDURANCE, AGILITY.

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INTRODUCTION

The youth of the country is a national asset and its development is a task of great significance and importance. The NCC has the expertise and built-in infrastructure to fulfill this mandate. Over the years NCC has contributed towards achieving this goal in an effective and meaningful manner. The National Cadet Corps (NCC) holds a golden key for all-round growth and transformation of our youth. What began in the year 1917, as the University Corps, after many changes and overhauls through the years, has come to be known as the National Cadet Corps (NCC) since November 1948. Today, with nearly 14 lakh cadets, both boys and girls, from over 13000 colleges and schools inclusive of those in remote and far flung areas, on its roll, the NCC is projected as the largest disciplined, uniformed youth organization in the world.

Motor fitness is one of the components of the total fitness of the individual, which also includes mutual, social and emotional fitness. It is one of the basic requirements of life broadly speaking it means the ability to carryout our daily tasks without under fatigue.

Strength endurance is required in all sports movement, whether fast or slow, movements have to be done under lesser or higher conditions of fatigue. Agility is a combination of several athletic traits such as strength, reaction time, speed of movement, power and co-ordination. It's display becomes essential in such movements as dodging, zigzag running, stopping and starting and changing body positions quickly.

Plyometric is a method of developing explosive power, an important component of the athletic performance as plyometric movements are performed in a wide spectrum of sports. In badminton, it can be played more skillfully when players have the power that combines with strength and speed to develop explosive power for participating in various sports activities. The aerobic and anaerobic exercises improve significantly in developing motor fitness variables of the badminton players.

METHODOLOGY

The purpose of the study was to find out the changes on selected motor fitness components in response to combination of aerobic and anaerobic training among college NCC students. To achieve this purpose, thirty male college NCC students were selected as subjects, their aged between 18 to 25 years, they are studying in the various college of Chennai, Tamilnadu The selected subjects were divided into two equal groups of fifteen subjects each, namely combination of aerobic and anaerobic training group and control group. The selected subjects had undergone the combination of aerobic and anaerobic training for eight weeks, with three days per week in alternate days. After 10 to 15 minutes of warm-up the subjects underwent their respective three sets per exercise per session at 60 to 80% with a progressive increase in load with the number of weeks. The control group did not participate in any specialized training during the period of study. Strength endurance and agility were selected as criterion variables and they were tested by using sit-ups and shuttle run respectively. ANCOVA was used to find out the significant difference if any between the groups.

EXPERIMENTAL DESIGN AND STATISTICAL PROCEDURE

The experimental design used for the present investigation was random group design involving 30 subjects for training effect. Analysis of Covariance (ANCOVA) was used as a statistical technique to determine the significant difference, if any, existing between pretest and posttest data on selected dependent variables separately and presented in Table-I.

TABLE – I

Variables	Test		Combination of Aerobic and Anaerobic Training Group	Control Group	Source of Variance	SS	df	Mean Square	'F' Ratio
Strength Endurance	Pre test	Mean	47.00	47.27	Between	0.533	1	0.533	**0.112**
		S.D	1.93	2.40	Within	132.92	28	4.75	
	Post test	Mean	52.92	47.52	Between	218.700	1	218.7	**48.344**
		S.D	2.16	2.10	Within	126.67	28	4.53	
	Adjusted Post test	Mean	**52.94**	**47.52**	Between	233.785	1	233.785	**112.55**
					Within	56.081	27	2.077	

Agility	**Pre test**	**Mean**	10.93	10.99	**Between**	0.033	1	0.033	**0.742**
		S.D	0.252	0.162	**Within**	1.259	28	0.04495	
	Post test	**Mean**	10.73	10.96	**Between**	0.385	1	0.385	**22.049**
		S.D	0.123	0.141	**Within**	0.489	28	0.0175	
	Adjusted Post test	**Mean**	**10.73**	**10.96**	**Between**	0.336	1	0.336	**20.307**
					Within	0.446	27	0.01653	

RESULTS

The posttest mean of combination of aerobic and anaerobic training group and control group on strength endurance (52.92 ± 2.16 Vs 47.52 ± 2.10) resulted in a 'F' ratio of 48.344. The adjusted posttest mean of combination of aerobic and anaerobic training group and control group on strength endurance (52.94 Vs 47.52) resulted in a 'F' ratio of 112.55. The results of the study indicate that there was a significant difference between combination of aerobic and anaerobic training group and control group on strength endurance.

The posttest mean of combination of aerobic and anaerobic training group and control group on agility (10.73 ± 0.123 Vs 10.96 ± 0.141) resulted in a 'F' ratio of 22.049. The adjusted posttest mean of combination of aerobic and anaerobic training group and control group on agility (10.73 Vs 10.96) resulted in a 'F' ratio of 20.307. The results of the study indicate that there was a significant difference between combination of aerobic and anaerobic training group and control group on agility.

CONCLUSION

Based on the results of the study, it was concluded that the combination of aerobic and anaerobic training program has resulted in significant increase in selected motor fitness components such as strength endurance and agility.

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EFFICACY OF SAND SURFACE TRAINING ON SELECTED SKILL PERFORMANCE VARIABLE AMONG BADMINTON PLAYERS

❒ Sajeed KP*
Dr. S. Manikandan**

ABSTRACT

The purpose of the study was to find out the efficacy of sand surface training and plyometric training on selected skill variable among badminton players. To achieve this purpose, forty male badminton players were selected as subjects, their aged between 14 to 17 years; they are studying in the various schools of Lakshadweep. The selected subjects were divided into two equal groups of twenty subjects each, namely sand surface training group and control group. The experimental group trained for three alternative days in a week for sixteen weeks with four sets per exercise per session at 65 to 85% with a progressive increase in load with the number of weeks. Skill variable such as forehand clear in Badminton were selected as criterion variables and they were tested by using Miller Wall Volley Test. Dependent 't' test was used to find out the significant difference if any between the groups. The results of the study showed that there was a significant improvement on selected skill such as forehand clear in Badminton due to sixteen weeks of sand surface training as compared to control group.

Keywords : Sand surface, Training, Lakshadweep, Badminton, Skill.

Introduction

The Beach is a great place to enjoy fresh air for all kinds of people from all walks of life. One can do countless activities on the beach which is full of fresh air, sounds of the ocean and the smooth sand under the feet. One can do many exercises on sand without equipments. Exercises on the beach will provide health benefits for elite sports persons, professionals and people with health issues or injuries; older adults; and people who just want to have enjoyment.

Sand is a loose, fragmented, naturally-occurring material consisting of very small particles of decomposed rocks, corals, or shells.

(Mohanachandran, M.J., 2012) Badminton is a racquet sport played by either two opposing players (singles) or two opposing pairs (doubles), who take positions on opposite halves of a rectangular court divided by a net. Players score points by striking a shuttlecock with their racquet so that it passes over the net and lands in their opponents' half of the court. Each side may only strike the shuttlecock once before it passes over the net. A rally ends once the shuttlecock has struck the floor, or if a fault has been called by the umpire at any time during the rally.

(Bernd, V., 2014) Badminton offers a large variety of strokes, to perform all of them effectively players need a high level of talents. In the stroke clear, shuttlecock is hit right to the opponent's back boundary line, and there are two types, the attacking and the defensive clear. It is the trajectory that determines the type of clear. The Attacking clear is the hit fast and low, while the defensive clear is hit high.

An experienced player should be able to hit from his own back boundary line to the opponent's. A prerequisite for an effective hit is that it should be hit as high as possible and in front of the body.

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Objectives of the study

Objective of the study was to measure the improvement of selected skill performance variable namely forehand clear in the Badminton players of Lakshadweep.

Hypothesis

It is hypothesized that there will be significant Improvement due to Sixteen weeks "Sand Training" on selected Skill performance variables of Lakshadweep Badminton players.

Methodology

The purpose of the study was to find out the efficacy of sand surface training on selected Skill performance variables among badminton players. To achieve this purpose, forty male badminton players were selected as subjects, their aged between 14 to 17 years, they are studying in the various school of Lakshadweep. The selected subjects were divided into two equal groups of twenty subjects each, namely sand surface training group and control group.

The experimental group went through the sand surface training program for sixteen weeks. The training was given for three days in a week in alternate days from 7.am to 8.am. The control group did not participate in any specialized training during the period of study.

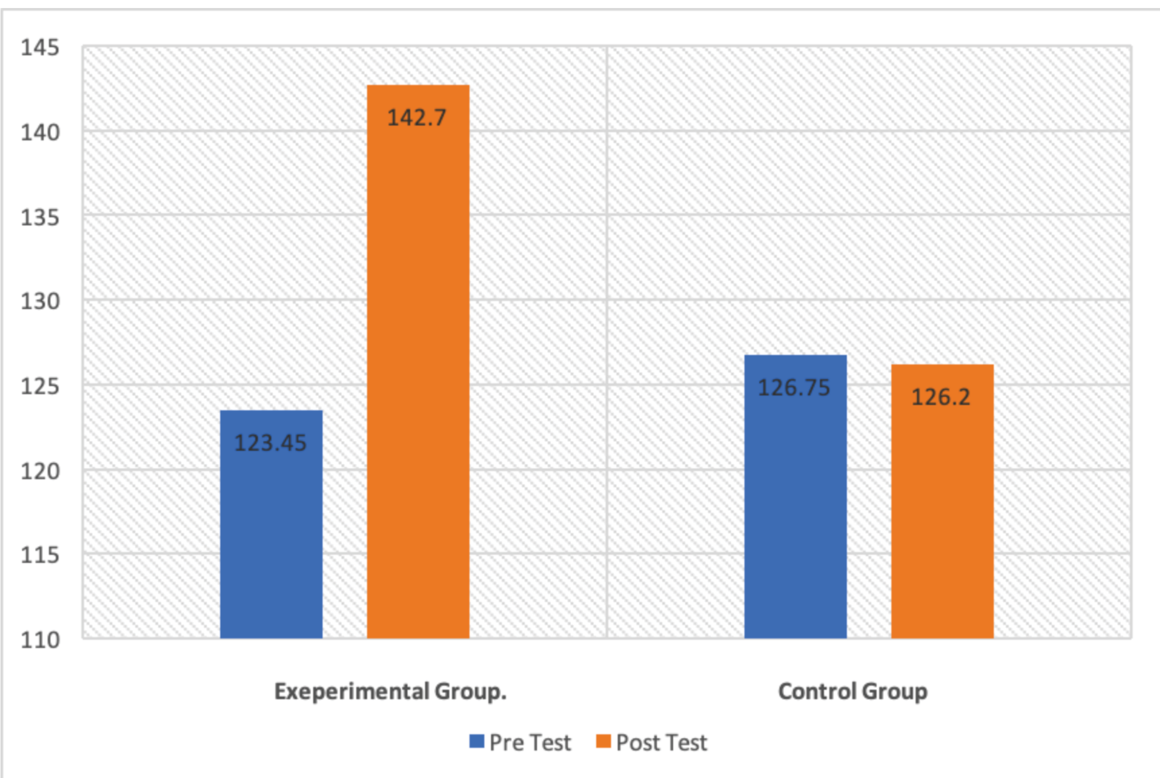
Statistical procedure and analysis of data

Statistical analysis was carried out with descriptive statistics and dependent 't' test which were used to determine the significance in the measured variables between pre-training and post-training. The result was presented as means (SD) $p<0.05$ was accepted as significant.

Table-I: T-ratio of experimental and control group on clear

Control Factors	Pre test			Post test			Df	t-ratio
	N	Mean	SD	N	Mean	SD		
Exp	20	123.45	122.57	20	142.7	47.27	19	3.827
Control	20	126.75	88.72	20	126.2	70.69	19	0.585

Figure-I: Pre-and post mean score on clear



Results and Discussion

Sixteen weeks of sand surface training program had improved selected skill performance variable of Lakshadweep badminton players namely the skill Clear. They had also been through their regular coaching schedule and this probably could have been one of the reason for the improvement. The subjects had enthusiastically participated in the training program since they found the training to be interesting due to the freshness of the exercise, they did something that was different from the usual routine which ensured their whole-hearted participation leading to the improvement in their Clear.

Conclusion

Based on the results of the study, it was concluded that

- There was a significance difference among sand surface training group and control group.
- The results of the study revealed that there was a significant improvement on selected skill performance variable of badminton players such as Clear due to sixteen weeks of sand surface training program.

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EFFECT OF SAQ TRAINING ON SELECTED PSYCHOMOTOR AND GAME SKILLS VARIABLES AMONG BASKETBALL PLAYERS

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Influence of directive play activities on motor development of school children

Dr. S Jayakumar and Dr. C Lakshmanan

Abstract
The purpose of the study was to find out the effect of directive play activity on cognitive and motor development of primary school children. Cognitive variables such as concentration and executive function and motor development variables such as locomotor skills and object control were selected as the independent variables for the study. Two hundred school students (N=200) were selected as subjects for the study. The subjects selected from SRM Public school Chennai. Hundred school students (n=100) equally from boys and girls formed the experimental group which underwent twelve weeks of directive play activity program (DPAG). Hundred students (n = 100) selected equally from boys and girls formed the control group (CG). The subjects were in the age group of 5-8 years. The pre and post test data on the dependent variables were collected before and after the experimental period of twelve weeks. Standardized tests namely; Concentration Grid Test, Trial Making Test (TMT) and Test of Gross Motor Development-2 were used to collect data on cognitive and motor variables. Analysis of Covariance revealed that there was a significant improvement in the Motor variables of Running, Galloping, Hopping, Jumping, Leaping, Sliding, Two-hand strike, Stationary bouncing, Catching, Kicking, Over hand Throwing and Under hand rolling. Significant improvements were also proved in the Cognitive variable of Executive Function.

Keywords: Directive play, motor development

Introduction

Childhood is the important and critical period of life with critical effects on personality of individuals. In other hand, it is best period to help children learn adaptive behaviors and effective communicational skills (Kollbrunner & Seifert, 2013). In next periods of life, especially in of adolescence, these skills can provide corrective emotional strategies and healing in conflicts (Jager, 2013). Recently, effect of play therapy for improving of social skills has been noticed by most of the socio-science researchers (Stone & Stark, 2013). Many researchers believe that the lack of social-emotional skills educations considered as a reason for the failure of many children in school, it means that academic achievements need not only cognitive abilities but also social and emotional competence (Chari *et al*., 2013).

The goal of physical education for children is to enable them to develop health and activity habits that will become a lifestyle throughout adolescence and adulthood. The two most important factors in attaining this goal at the elementary school level are that the children. Enjoy the fitness activities and master the basic skills of physical education that will enable them to participate successfully in the activities that promote fitness. Only if fitness is fun will the children pursue it outside the two or three times they are with us in physical education class each week and on through middle school, high school, and beyond. Children must enjoy exercise and physical activity as well as understand and appreciate the importance of physical fitness if they are to develop lifelong health fitness habits. Fitness for health is not the same as conditioning for competitive sports participation. Therefore, we focus on the teaching and learning of skills, knowledge, and behavior's that will enable children to be physically active today, tomorrow, and throughout their adult life (Graham, Hale & Parker, 2006).

Methodology

For the purpose of the study two hundred (N=200) primary school children in the age group of six to eight (5-8) years were selected from SRM Public school Chennai.

The selected subjects were equally divided into (n=100) Directive Play Activity Group (DPAG) and Control Group (CG), both groups were equally represented by boys and girls fifty each (n=50). Directive Play Activity was the independent variable and dependent variables were motor development skills were Locomotor skills of running, Hopping, Galloping, Leaping, Horizontal Jumping and Sliding and Object Control skills of Two Hand Strike, Stationary bounce, Two Hand Strike, Stationary Bounce, Catch, Kick, Over Hand Throw and Under Hand Roll. Standardized tests namely; Concentration Grid Test, Trial Making Test (TMT) and Test of Gross Motor Development-2 were used to collect data on cognitive and motor variables. The training program was administered to the Directive Play Activity Group (DPAG) for twelve weeks. Analysis of covariance (ANCOVA) was applied for analyze the effect of the subjects.

Results and Discussions

Table 1: Mean comparison of motor development components between directive play activity group and control group

Motor Development component	Group	SV	Df	SS	MS	F	P value
Locomotor skill gallop	DAPG	Between	1	34.72	34.72	144.6*	0.00
	CG	Within	197	47.73	0.24		
Locomotor skill hop	DAPG	Between	1	44.45	44.45	16.22*	0.02
	CG	Within	197	71.72	2.74		
Locomotor skill leap	DAPG	Between	1	76.82	76.82	6.85*	0.03
	CG	Within	197	17.56	11.21		
Locomotor skill jump	DAPG	Between	1	36.31	36.31	6.91*	0.03
	CG	Within	197	37.50	5.25		
Locomotor skill slide	DAPG	Between	1	61.29	61.29	7.10*	0.02
	CG	Within	197	22.81	8.63		
Object control two hand strike	DAPG	Between	1	41.56	41.56	14.80*	0.00
	CG	Within	197	68.48	2.87		
Object control stationary bounce	DAPG	Between	1	115.43	115.43	34.76*	0.00
	CG	Within	197	59.23	3.32		
Object control catch	DAPG	Between	1	25.24	25.24	6.02*	0.04
	CG	Within	197	46.92	4.19		
Object control kick	DAPG	Between	1	47.63	47.63	21.35*	0.00
	CG	Within	197	88.20	2.23		
Object control over hand throw	DAPG	Between	1	39.41	39.41	15.45*	0.00
	CG	Within	197	77.18	2.55		
Object control	DAPG	Between	1	50.37	50.37	11.07*	0.03
	CG	Within	197	43.29	4.55		
Object control under hand control	DAPG	Between	1	59.29	59.29	23.16*	0.00
	CG	Within	197	76.71	2.56		

The table shows that, directive play activity program had a significant effect on the selected motor development components (p<0.05).

Discussion and Conclusions

Twelve weeks of directive play activity program had resulted in significantly improving the selected Motor Development Variables of Run, Gallop, Hop, Jump, Leap, Slide, Two Hand Strike, Stationary Bounce, Catch, Kick, Over Hand Throw and Under Hand Roll and Cognitive variable of Executive Function Directive play activity program mainly consist of movements.

Play activities and physical movement improves motor skills of children Directive play activities are specifically structured instructional program. It includes the contents of space awareness, pathways, travelling, chasing, dancing, jumping, balancing, kicking, throwing, catching, volleying, dribbling, striking CTC. There is a direct relationship between play activities and cognitive development of children. Play activities and physical movement makes an impact on the brain function. Parts of brain such as frontal lobe, temporal lobe (Memory), parietal lobe (sensory information), occipital lobe (Visual information), and cerebellum (Balance, coordination and attention)get activated when they engage in any play activity. Directive play activities are more effective than the normal play activities to improve brain function. Studies prove that frontal lobe of the brain helps in the executive function of children.

The findings of the study was in agreement with the findings of the study conducted by Tortella *et al.* (2016) who had investigated the specificity of structured and unstructured activities played at the playground on motor skill competence in five year old children. The results shows that the experimental group who practiced gross motor activities in the playground improved significantly on gross motor task.

The findings of the study was also in agreement with the findings of the study conducted by Good way, Crowe & Ward (2003). They had investigated the influence of a nine-week instructional program on locomotor and object control skill development of preschoolers who are at risk of developmental delay. The intervention group performed significantly better than the control group for both locomotor and object control skills. The findings were in consonance with the findings of the study conducted by Sibley & Etnier (2003) who had quantitatively combined and examined the results of studies pertaining to physical activity and cognition in children.

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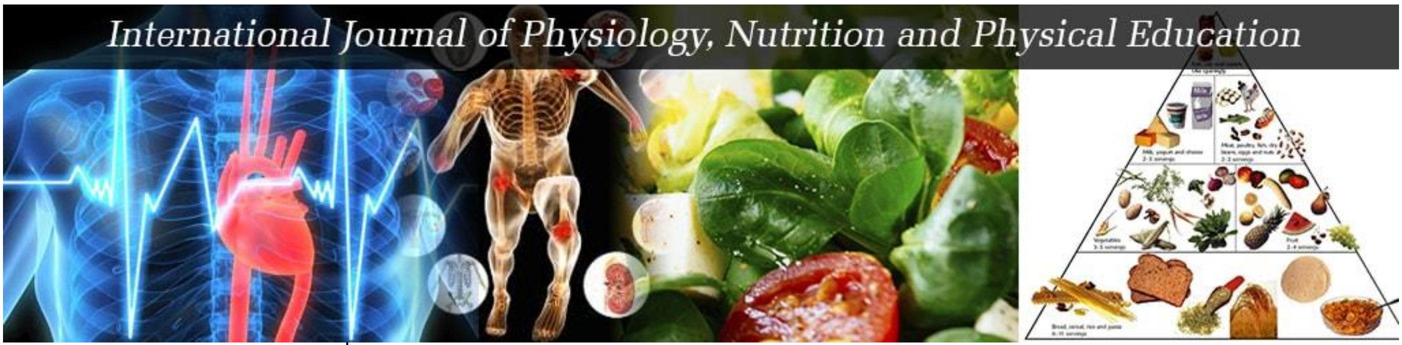

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Correlation of biochemical variables and long distance performance of cyclists

Dr. C Lakshmanan and Dr. S Jayakumar

Abstract
The purpose of the study was to find out the relationship of Biochemical variable of the performance of long distance cycling. Fifteen state level long distance Cyclists (men) were selected among the cyclist who participated in Tamilnadu state Cycling Championship. The age group of subjects ranged between 18-24 years. The Biochemical variables are (1) Total serum cholesterol (2) Serum Triglycerides (3) High density Lipo protein (4) Low density lipoprotein (5) Blood Hemoglobin (6) Red blood cells (7) White blood cells. The performance of long Distance cyclists were taken by conducted time trial in the presence of coach, for 80Km. road race. In case of the Biochemical variables, the subjects fasting blood samples Were collected and tested following standard techniques by Pathological experts. The descriptive statistics in terms of mean, standard deviation, range, standard error Skewness and Kurtosis were employed to present the data on selected Biochemical Variables of long distance cyclists. This study conclude that significant negative Correlation were obtained for (1) blood hemoglobin (2) red blood corpuscles to long Distance cycling performance. The correlation coefficients obtained for total cholesterol, Serum, triglycerides, High density lipoprotein cholesterol, low density lipoprotein Cholesterol and white blood corpuscles were -0.08,-0.30, 0.01, -0.01 and -0.23 Respectively, which were not statistically significant.

Keywords: Biochemical variables

1. Introduction

The sports performances are always interconnected and interlinked with many factors related to sports physiology, exercise physiology, biomechanics and anthropometric measurements. Sports performance area can be improved only through the co-ordinated functioning of allied branches mentioned above. In the above backgrounds those who work in this field should have thorough knowledge of these newly emerging branches of sports science.

Long distance cycling is considered to be a strenuous physical activity. This activity demands much preparation and training for successful participation in the event. These preparations include streamlining of eating habits, training schedules etc. The ultra endurance event of road cycling competition can be successfully conducted only if all these components are successfully managed.

Physiological differences between cycling and running are addressed: heart rate is different between the two activities both for maximal and sub-maximal intensities. The delta efficiency is higher in running. Ventilation is more impaired in cycling than in running. It has also been shown that pedaling cadence affects the metabolic responses during cycling (Zmuda, 2015) [6].

The endurance capacity can be increased only through increasing the aerobic capacity. Endurance training is a process involving several stages progressively. The length of the training programme depends upon the availability of time. The athletes are given basic endurance training in the first stage. The specific endurance can be started only after achieving the basic endurance. Only then can the athletes be brought up to the competitive participation level, to ensure better performance.

Running and cycling activity is performed by muscle contraction of the Introduction lower limbs. The main muscle group that are involved in cycling and running are the quadriceps and plantar flexors respectively. An exception to this is during uphill running when the recruitment of the quadriceps muscle is increased. Along with this remarkable physiological differences are also taken into account.

The aerobic capacity of the athletes is increased through regular exercise for a longer period. This is accomplished through the incremental difference in the heart size. It is through the regular exercise of the athlete that the heart muscles indirectly get exercised. The heart size is increased as a result of these exercises. The increase in heart size through endurance training is manifested in the increase of size of the left ventricle. Previously it was thought that the increased capacity of left ventricle is a hereditary factor. Now studies and research in this area has revealed that the increase in size of the left ventricle is largely due to the training and due to some hereditary factor, to some extent.

The relationship between exercise and blood lipid levels has been investigated extensively in recent years. Cross sectional studies find that, compared with non athletes, athletes generally have higher levels of HDL cholesterol, while levels of total and LDL cholesterol may be similar or some what lower. When body weight is maintained during an exercise programme modestly favorable changes in blood lipids are observed (i.e. decrease in total and LDL cholesterol and increase in HDL cholesterol). These changes are more pronounced when weight loss occurs during the exercise programme (Maston *et al*., 2013) [4].

2. Methodology

Fifteen long distance cyclists were selected for the present study and the long distance Cyclists were selected from the cyclists participated in Tamil Nadu state Cycling Championship (men). The age group ranged between 18-24 years. Biochemical Variables Fasting blood samples were drawn from the anticubitor veins of the subjects and the selected lipoprotein variables were analysed by enzymatic method following Wybenga and Pillegi‟s method, blood hemoglobin by Cynmacthoglobin method and R.B.C and W.B.C following standard procedures. The data for the biochemical variables were obtained from the subjects' fasting blood samples were collected and tested following Standard techniques by Pathological experts.

2.1 Biochemical variables

1. Total serum cholesterol measured in mg/dl.
2. Serum triglycerides measured in mg./dl.
3. High density Lipoprotein measured in mg./dl.
4. Low density Lipoprotein measured in mg./dl.
5. Blood hemoglobin measured in M. mol./ litre
6. Red blood cells measured in millions per cubic millimeter blood
7. White blood cells measured in cubic millimeter of blood.

3. Statistical techniques

The descriptive statistics in terms of mean, standard deviation, standard error, were employed to present the data on selected biochemical variables of cyclists. The relationship of biochemical variable to the performance of long distance runners and cyclists were found out by using Pearson's product moment correlation. The level of significance employed was set at 0.05.

4. Results and Discussions

The data collected by adopting above procedure were statistically analyzed. The results are presented in the following table.

Table 1: Descriptive Statistics selected biochemical variables of state level cyclists

Variables	Mean	SD	SE
Total Cholesterol	192.53	32.75	8.46
Serum Triglyceride	101.2	10.34	2.66
High Density Lipoprotein Cholesterol	53.07	14.52	3.75
Low density Lipoprotein Cholesterol	123.87	33.92	8.76
Blood Hemoglobin	13.06	0.69	0.18
RBC	4.29	0.43	0.11
WBC	8240	169.18	437.9

Table 1 reveals that mean value and standard deviation of total cholesterol were 192.53, 32.75 respectively. Serum triglyceride mean and standard deviation value is 101.2 and 10.34 respectively. High density and low-density lipoprotein cholesterol mean and standard deviation values is 53.07, 14.52, 123.87 and 33.92 respectively. Blood hemoglobin, RBC and WBC mean and standard deviation values is 13.06, 4.29, 8240, 0.69, 0.43 and 169.18 respectively.

Table 2: Coefficient correlation of selected biochemical variables to long distance cycling performance

Sl No	Variables	Co efficient correlation
1	Total Cholesterol and cycling performance	-0.08
2	Serum Triglyceride and cycling performance	-0.30
3	High Density Lipoprotein Cholesterol and cycling performance	0.01
4	Low density Lipoprotein Cholesterol and cycling performance	-0.01
5	Blood Hemoglobin and cycling performance	-0.50
6	RBC corpuscles and cycling performance	-0.55
	WBC corpuscles and cycling performance	-0.23

*Significant at 0.05 level, r-value is 0.497

Table 2 reveals the coefficient of correlation of selected biochemical variable and cycling Performance of long distance cyclist. Significant negative correlation was observed between blood hemoglobin and cycling performance (-0.50*). Besides blood hemoglobin, significant negative correlation was observed between red blood corpuscles and cycling performance (-0.55). The correlation of coefficient obtained for total cholesterol, serum triglycerides, high density Lipoprotein cholesterol, low density lipoprotein cholesterol and white blood corpuscles were 0.08, -0.30, 0.01, -0.01 and -0.23 respectively which were not statistically significant.

5. Discussions

All forms of athletic training associated with the improvement of cardiac performance and changes in biochemistry. The exacts effects on these factors depend upon the type of training and the nature of activities involved. Long distance cycling improve the endurance capacity of the athletes, since these activities are prolonged and aerobic in nature.

The findings regarding biochemical variables to cycling performance, blood hemoglobin and red blood corpuscles were significantly related. The relationship of hemoglobin and red blood cells to performance of cycling is quite obvious since both hemoglobin and red blood corpuscles are concerned with oxygen carrying capacity and the diffusion capacity of the cardio-respiratory functions. The study supported by the study conducted by (Hartung, 2012) [2].

6. Conclusions

Recognizing the limitation of the present study the following conclusions may be drawn.

1. There is significant negative relationship between blood hemoglobin and long distance cycling performance.
2. There is significant negative relationship between red blood corpuscles and long distance cycling performance.

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EFFECT OF YOGIC PRACTICES WITH AND WITHOUT DIET MODIFICATIONS ON SELECTED RISK FACTORS AMONG MEN WITH ANDROPAUSE

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Abstract

The present study was designed to find out the effect of Yogic practices with and without diet modifications on systolic blood pressure among Men with Andropause . It was hypothesized that there would be significant differences in systolic blood pressure among Men with Andropause due to the influences of Yogic practices with and without diet modifications. To achieve the purpose of the study, 45 Men with Andropause from Chennai aged between 50 and 55 years. The Experimental group I and II underwent Yogic practices with and without diet modifications for the period of 6 weeks of an hour in the morning. The control group was not exposed to any specific training but they participated in the regular activities. The pre-test and post-test were conduct before and after the training for three groups. The data pertaining to the variables collected from the three groups before and after the training period were statistically analyzed by using Analysis of Covariance (ANCOVA) to determine the significant difference and tested at 0.05 level of significance.

Keywords: Yogic Practices, Diet Modifications, Systolic Blood Pressure, Men with Andropause.

INTRODUCTION

Since the modern man developed mostly upon modern out fits for his daily routine, involving mainly his mental powers to live an easy going life, there has been a fall and deterioration in his Physical Health and capacities. Modern man need not toil like his forefather for his daily life. So he has become less vigorous and lethargic. Every individual should develop his strength and endurance for a happy and effective living. In order to get proper strength and endurance one has to involve in physical activities. The immune system is the body's system of defense against disease. It combats disease in a number of ways (Jiang & Chess, 2006). Your body is constantly engaged in search and destroy missions against invading microbes, even as you're reading this page. Millions of white blood cells, or leukocytes, are the immune system's foot soldiers in this microscopic warfare. Leukocytes systematically envelop and killopathogens such as bacteria, viruses, and fungi, worn-out body cells, and cells that have become cancerous.

Leukocytes recognize invading pathogens by their surface fragments, called antigens, literally antibody generators. Some leukocytes produce antibodies, specialized proteins that lock into position on an antigen, marking them for destruction by specialized "killer" lymphocytes that act like commandos on a search-and-destroy mission (Greenwood, 2006; Kay, 2006).

Pancha Kosha - the Subtle Energy Body or 'Five Sheaths'

The subtle anatomy of the humans is divided into five energetic sheaths known as 'pancha kosha'. Pancha, meaning five and kosha, meaning layer or sheath. This ideology describes the human being "as multi-dimensional, with the source or foundation in a spiritual dimension." The so-called 'spiritual dimension' is pure consciousness which is hidden by the other four koshas, the outermost layer being the most dense, physical body. Each kosha can be thought of as energy vibrating at a different frequency. The physical body therefore vibrates at the slowest rate and the 'inner light of consciousness' or 'atman' vibrates at fastest rate or frequency. Although all five layers interpenetrate one another.

These five sheaths can be divided into three bodies:

1. Sthula Sharira / Physical Body

   - Annamayakosha

2. Sukshma Shariria / Astral Body

   - Pranamayakosha, Manomayakosha, Vijnanamayakosha

3. Karana Shariria / Causal Body

- Vijnanamayakosha, Anandamayakosha

Of all these, the anandamayakosha is not bound by time or space and does not die. When the practitioner resides in this sheath, they have remembered or realized their true nature, reached enlightenment and health will pervade all layers. Andropause, the male menopause, low Testosterone regardless of name, the condition is characterized by a number of uncomfortable symptoms, including hot flashes in men, erectile dysfunction, low libido, irritability, muscle loss, and fatigue that are the result of low levels of testosterone. For men, testosterone production gradually decreases across the lifespan. According to a study published in the International Journal of Clinical Practice, nearly 40 percent of men over the age of 45 are affected by low testosterone. Declines in testosterone begin in a man's late 20s and continue to recede, reaching noticeably low levels around middle age, when men begin to experience symptoms of andropause or low testosterone.

STATEMENT OF THE PROBLEM

The present study was to find out the effect of Yogic practices with and without diet modifications on systolic blood pressure among Men with Andropause.

METHODOLOGY

To achieve the purpose of the study, 45 Men with Andropause from Chennai aged between 50 to 55 years were selected randomly into experimental group I, experimental group II and control groups of 15 subjects each. The selected subjects were divided into two experimental group I, II and control group with 15 subjects each in a group. Experimental Group I underwent yogic practices with diet modifications for the period of 6 weeks for the maximum of an hour in the morning and the Experimental Group II underwent yogic practices without diet modifications for the period of 6 weeks for the maximum of an hour in the morning. The control group (CG) was not exposed to any specific training but they participated in the regular activities.

TABLE – I

ANALYSIS OF COVARIANCE OF THE MEANS OF TWO EXPERIMENTAL GROUPS AND THE CONTROL GROUP IN SYSTOLIC BLOOD PRESSURE

Tests/ Groups	EX.GR-I	EX.GR-II	CG	SOV	Sum of Squares	df	Mean Squares	"F" Ratio
Pre Test	141.933	141.47	141.60	between	1.73	2	0.867	0.06
				within	576.27	42	13.72	
Post Test	128.933	130.40	141.27	between	1361.73	2	680.87	18.22*
				within	1569.47	42	37.37	
Adjusted Post Test	128.88	130.44	141.28	between	1368.55	2	684.28	18.19*
				within	1542.468	41	37.62	
Mean Gain	13	11.07	0.33					

* F(0.05) (2,42 and 2, 41) = 3.23. *Significant at 0.05 level of confidence.

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TABLE II

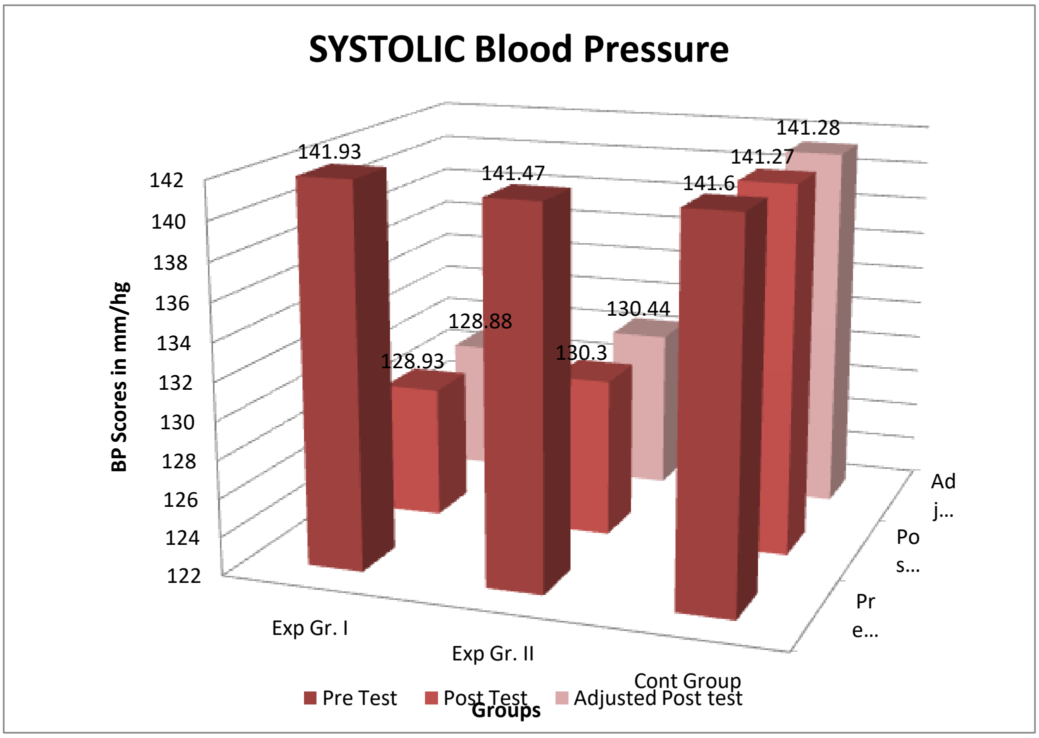
SCHEFFE'S POST-HOC TEST FOR SYSTOLIC BLOOD PRESSURE

Mean Values			MD	Required C.I
EX.GR-I	***EX.GR-II***	***CG***		
128.88	130.44	-	1.57*	1.14
128.88	-	141.28	12.41*	
-	130.44	141.28	10.84*	

* Significant at 0.05 level.

FIGURE – 1

BAR DIAGRAM SHOWING THE MEAN DIFFERENCE AMONG EXPERIMENTAL GROUP I, EXPERIMENTAL GROUP II AND CONTROL GROUP OF SYSTOLIC BLOOD PRESSURE



DISCUSSION ON FINDINGS

The results of the study indicated that the experimental groups namely Yogic practices with and without diet modifications had significantly on the selected dependent variables such as systolic blood pressure.

The results of the study showed that systolic blood pressure decreased significantly as a result of Yogic practices with and without diet modifications. Hence, the hypothesis was accepted at 0.05 level of confidence. Systematic Yogic practices with and without diet modifications increase the systolic blood pressure. The above findings can also be substantiated by observation made by renowned expert .

CONCLUSION

1. During pre and post tests, both the experimental groups exhibited a significant decrease on systolic blood pressure immediately after the practices than the control group.

2. The Yogic practices with and without diet modifications helped to decrease the systolic blood pressure among the Men with Andropause.

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Predict the Playing Ability from Selected Psychological Variables among Sports Authority of India Training Centre Hockey Players in Southern India

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Abstract

The purpose of the study was to predict the hockey playing ability from selected psychological variables among Sports Authority of India Training Centre Hockey Players in Southern India. To achieve the purpose, one hundred and fifty men hockey players were selected from Sports Authority of India Training Centre, Southern India and their age ranged from 18 to 25 years. The subjects had the past playing experience of at least one year in hockey. In this study, the hockey playing ability was predicted from one hundred and fifty hockey players with the help of predictor variables such as the Psychological variables namely – Self Confidence, Aggression and Motivation were assessed by standard questionnaires. The playing ability which was taken as the performance factor was subjectively assessed by three qualified hockey coaches. The present study consisted of one dependent variable, namely playing ability of hockey players and three independent variables. Collected data was subjected to statistical analysis as explained below. Descriptive statistics and Pearson's correlation coefficients were applied to establish the relationships among the variables measured. The computation of multiple regressions was also used. In multiple regressions, a criterion variable from a set of predictors was predicted. Step wise argument methods of multiple regressions were used in this study to find out the predictor variable that had the highest correlation with the criterion variables entered in the equation depending on the contribution of each predictor. The results revealed that the self confidence become the common characteristics which can predict the Hockey playing ability among hockey players.

Keywords: Psychological Variables, SAI, Hockey Players, Southern India.

Introduction

Field hockey is an intermittent endurance sport involving short sprinting also as movement with and without ball. In hockey, players are to bend forward to the bottom for the utmost groundwork and to hide a wider range all around during the sport. To play hockey well it also involves intelligence, keen eyes, powerful wrists, fitness and therefore the speed of mind and body. This shows that the sport hockey is of great skills, concentration of the ball and body control and determination. Ability to execute all strokes with real skill and necessary speed are the essential qualities for a top player (Dureha & Akhil, 2003). One of the goals of research project is to predict future events or results from present or past data. There are differing types of prediction that we encounter in our lifestyle, like wealth forecast, market forecast, share market forecast, election trends etcetera. These are based upon some known facts then they're reliable prediction. Research within the field of sports and games had proved that the longer term performance of a private or team might be predicted through the analysis of certain variables, which are found to be the idea for total performance.

Materials and Methods

The purpose of the study was to predict the hockey playing ability from selected psychological variables among Sports Authority of India Training Centre Hockey Players in Southern India. To achieve the purpose, one hundred and fifty men hockey players were selected from Sports Authority of India Training Centre, Southern India and their age ranged from 18 to 25 years. The subjects had the past playing experience of at least one year in hockey. In this study, the hockey playing ability was predicted from one hundred and fifty hockey players with the help of predictor variables such as the Psychological variables namely – Self Confidence, Aggression and Motivation were assessed by standard questionnaires. The playing ability which was taken as the performance factor was subjectively assessed by three qualified hockey coaches. The present study consisted of one dependent variable, namely playing ability of hockey players and three independent variables. Collected data was subjected to statistical analysis as explained below. Descriptive statistics and Pearson's correlation coefficients were applied to establish the relationships among the variables measured. The computation of multiple regressions was also used. In multiple regressions, a criterion variable from a set of predictors was predicted. Step wise argument methods of multiple regressions were used in this study to find out the predictor variable that had the highest correlation with the criterion variables entered in the equation depending on the contribution of each predictor.

Results

Table I. Correlation Matrix of Playing Ability selected psychological variables among Sports Authority of India Training Centre Hockey Players in Southern India

	SC	AGG	MOT	PA
SC	1	0.152	0.162*	0.028
AGG		1	0.006	0.122
MOT			1	0.419**

*Significant at 0.05 level ** Significant at the 0.01 level

Table II. Descriptive statistics of selected psychological variables among Sports Authority of India Training Centre Hockey Players in Southern India

S.No	Variables	Minimum	Maximum	Range	Mean	SD (±)
1	Self Confidence	28.00	34.00	6.00	31.25	1.87
2	Aggression	8.00	20.00	12.00	14.09	2.25
3	Motivation	6.00	18.00	12.00	13.22	1.64
4	Playing Ability	6.00	9.00	3.00	7.06	1.02

Table – I showed the descriptive statistics –Minimum, Maximum, Range, Mean and Standard deviation of selected psychological variables and the playing ability. The present study attempted to link the coaches rating as measure of playing ability in hockey from selected psychological variables among hockey Players.

Table III. Analysis of variance for the influence of independent variables on playing ability among Sports Authority of India Training Centre Hockey Players in Southern India

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.292	1	4.292	4.151*	.043[b]
	Residual	153.041	148	1.034		
	Total	157.333	149			
2	Regression	8.475	2	4.237	4.184*	.017[c]
	Residual	148.859	147	1.013		
	Total	157.333	149			

It was clear from the table – III that the obtained F value, 4.151 and 4.184 respectively were significant at 0.05 level. It revealed that two independent variables were collectively influenced on the playing ability in hockey. As the F ratio was significant, multiple regressions were computed. Multiple regression equation was computed only because the multiple correlations were sufficiently high to warrant prediction from it. Then, the correlation identified the independent variables to be included and their order in the regression equation. Multiple correlations were computed by step wise argument method on data of Hockey players and the results were presented in Table – IV.

Table IV. Step wise multiple regression between playing ability in hockey and independent variables among Sports Authority of India Training Centre Hockey Players in Southern India

Model	Variables	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	Self confidence	.972[a]	.944	.942	.238
2	Motivation	.973[b]	.946	.944	.234

From Table – IV, it was found out that the multiple correlations co – efficient for predictors, such as self confidence and motivation was 0.973 which produced highest multiple correlations with hockey playing ability. 'R' square values showed that the percentage of contribution of predictors to the Hockey playing ability (Dependent variables) is in the following order.

1. About 97% of the variation of playing ability in hockey was explained by the regression model with two predictors self confidence and motivation.

   Multiple regression equation was computed and the results were presented in Table – V.

Table V. Regression analysis of prediction equation of Sports Authority of India Training Centre Hockey Players in Southern India

Model		Unstandardized Coefficients		Standardized Coefficients	Sig.	Partial Correlations	Collinearity Statistics
		B	Std. Error	Beta			
Step1	(Constant)	9.889	1.388		7.126	.000	
	SC	-.090	.044	-.165	- 2.037	.043	1.000
Step 2	(Constant)	9.425	1.392		6.771	.000	
	SC	-.128	.048	-.234	- 2.689	.008	0.848
	MOT	.077	.038	.177	2.032	.044	0.848

In the Table – V, the following regression equations were derived for playing ability of Hockey players with dependent variables.

Regression Equation in obtained scores from = CR

Playing Ability (CR) = 9.889 -0.128(SC) +0.077(MOT)

C.R	Playing ability
SC	Self confidence
MOT	Motivation

The regression equation for the prediction of playing ability in hockey includes self confidence and motivation. As the multiple correlations on Hockey playing ability with the combined effect of these independent variables are highly significant, it is apparent that the obtained regression equation has a high predictive validity.

Conclusion

1. The results revealed that an Inter – relationship exists significantly between the psychological variables among hockey players.
2. The regression equation developed by two variables can be put in to prediction equation of hockey players.
3. The results revealed that the self confidence and motivation become the common characteristics which can predict the Hockey playing ability among hockey players.

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Prediction of Playing Ability from Selected Physiological Variables among Sports Authority of India Training Centre Hockey Players in Southern India

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Abstract

The purpose of the study was to predict the hockey playing ability from selected physiological variables among Sports Authority of India Training Centre Hockey Players in Southern India. To achieve the purpose, one hundred and fifty men hockey players were selected from Sports Authority of India Training Centre, Southern India and their age ranged from 18 to 25 years. The subjects had the past playing experience of at least one year in hockey. In this study, the hockey playing ability was predicted from one hundred and fifty hockey players with the help of predictor variables such as the Physiological variables namely – Resting Heart Rate (Stethoscope), Breath Holding Time (Nose Clip), Systolic Blood Pressure and Diastolic Blood Pressure (Digital Blood Pressure Monitor). The playing ability which was taken as the performance factor was subjectively assessed by three qualified hockey coaches. The present study consisted of one dependent variable, namely playing ability of hockey players and four independent variables. Collected data was subjected to statistical analysis as explained below. Descriptive statistics and Pearson's correlation coefficients were applied to establish the relationships among the variables measured. The computation of multiple regressions was also used. In multiple regressions, a criterion variable from a set of predictors was predicted. Step wise argument methods of multiple regressions were used in this study to find out the predictor variable that had the highest correlation with the criterion variables entered in the equation depending on the contribution of each predictor. The results revealed that the breath holding time and resting heart rate become the common characteristics which can predict the Hockey playing ability among hockey players.

Keywords: Physiological Variables, SAI, Hockey Players, Southern India.

Introduction

Life won't be life without physical activities. Through physical activities alone people were ready to survive during this world. The story of evolution throws some light on the character and kinds of activities which are an important a part of modern physical activities which are to be fit day-to-day existence and to satisfy the occasional emergencies that arise. Whatever may the emergency that trust itself on individuals the citizenry need to readjust and keep it up. Research within the field of education and Sports is very demand of the day. Researches during this field brought numerous technologies in and equipments manufacturing. We will say that the progress of the sector directly linked with research. It's incontrovertible fact that at the present situation research in education and Sports is a crucial area of study to enhance the sports performance. The past decades have seen the increase of a neighborhood of study called futurism or futuristic, which attempts to scientifically examine the longer term. The sports scientists have tried to predict the success of sports performance during competition. Physiology is that the science of functioning of all the organs and systems of an organism. For the physiological system of the body to be fit, they need to function tolerably to support to specific activity that the individual is performing more over different activity make different demands upon the organism with reference to circulatory, respiratory, metabolic and neurologic process which are specific to the activity. Physiological variables could also be defined as those variables which are directly linked with various physiological systems like pulse, vital capacity, fat percentage, rate of respiration and hemoglobin. High level of performance in sports and games could be dependent upon the physiological structure and it had been recognized that physiological proficiency was needed for the high level performance. What proportion athletic ability present during a particular person is due to genetics and the way much is decided by training and other adaptations made by the athlete (Bharathiraja et al. 2015).

He must have the technical ability to perform the varied skills that the sport of hockey requires. These include scooping, passing, pushing, lifting and dribbling with precision accuracy and confidence. Perfection in pushing, hitting, scooping and dribbling is most vital for all good players regardless of the position they play except the goal keeper (Vimalnat, 2012).

Materials and Methods

The purpose of the study was to predict the hockey playing ability from selected physiological variables among Sports Authority of India Training Centre Hockey Players in Southern India. To achieve the purpose, one hundred and fifty men hockey players were selected from Sports Authority of India Training Centre, Southern India and their age ranged from 18 to 25 years. The subjects had the past playing experience of at least one year in hockey. In this study, the hockey playing ability was predicted from one hundred and fifty hockey players with the help of predictor variables such as the Physiological variables namely – Resting Heart Rate (Stethoscope), Breath Holding Time (Nose Clip), Systolic Blood Pressure and Diastolic Blood Pressure (Digital Blood Pressure Monitor). The playing ability which was taken as the performance factor was subjectively assessed by three qualified hockey coaches. The present study consisted of one dependent variable, namely playing ability of hockey players and four independent variables. Collected data was subjected to statistical analysis as explained below. Descriptive statistics and Pearson's correlation coefficients were applied to establish the relationships among the variables measured. The computation of multiple regressions was also used. In multiple regressions, a criterion variable from a set of predictors was predicted. Step wise argument methods of multiple regressions were used in this study to find out the predictor variable that had the highest correlation with the criterion variables entered in the equation depending on the contribution of each predictor.

Results

Table I. Correlation Matrix of Playing Ability selected physiological variables among Sports Authority of India Training Centre Hockey Players in Southern India

	RHR	BHT	SYS	DIAS	PA
RHR	1	0.639**	0.095	0.113	0.198*
BHT		1	0.050	0.007	0.199*
SYS			1	0.035	0.016
DIAS				1	0.099

*Significant at 0.05 level ** Significant at the 0.01 level

Table II. Descriptive statistics of selected physiological variables among Sports Authority of India Training Centre Hockey Players in Southern India

S.No	Variables	Minimum	Maximum	Range	Mean	SD (±)
1	Resting Heart Rate	66.00	71.00	5.00	68.80	1.57
2	Breath Holding Time	32.13	48.67	16.54	42.33	1.87
3	Systolic Blood Pressure	119.00	123.00	4.00	120.88	0.75
4	Diastolic Blood Pressure	80.00	83.00	3.00	81.00	0.72
5	Playing Ability	6.00	9.00	3.00	7.06	1.02

Table – I showed the descriptive statistics –Minimum, Maximum, Range, Mean and Standard deviation of selected physiological variables and the playing ability. The present study attempted to link the coaches rating as measure of playing ability in hockey from selected physiological variables among hockey Players.

Table III. Analysis of variance for the influence of independent variables on playing ability among Sports Authority of India Training Centre Hockey Players in Southern India

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.232	1	6.232	6.104*	.015[b]
	Residual	151.102	148	1.021		
	Total	157.333	149			
2	Regression	9.956	2	4.978	4.965*	.023[c]
	Residual	147.377	147	1.002		
	Total	157.333	149			

It was clear from the table – III that the obtained F value 6.104 and 4.965 respectively were significant at 0.05 level. It revealed that two independent variables were collectively influenced on the playing ability in hockey. As the F ratio was significant, multiple regressions were computed. Multiple regression equation was computed only because the multiple correlations were sufficiently high to warrant prediction from it. Then, the correlation identified the independent variables to be included and their order in the regression equation. Multiple correlations were computed by step wise argument method on data of Hockey players and the results were presented in Table – IV.

Table IV. Step wise multiple regression between playing ability in hockey and independent variables among Sports Authority of India Training Centre Hockey Players in Southern India

Model	Variables	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	Breath Holding Time	.744[a]	.554	.543	.69955
2	Resting heart rate	.751[b]	.563	.550	.69350

From Table – IV, it was found out that the multiple correlations co – efficient for predictors, such as breath holding time and resting heart rate was 0.751 which produced highest multiple correlations with hockey playing ability. 'R' square values showed that the percentage of contribution of predictors to the Hockey playing ability (Dependent variables) is in the following order.

1. About 74% of the variation of playing ability in hockey was explained by the regression model with one predictor breath holding time.
2. About 75% of the variation of playing ability in hockey was explained by the regression model with two predictors - breath holding time and resting heart rate. An additional 1% of the variance in the hockey playing ability was contributed by resting heart rate.

   Multiple regression equation was computed and the results were presented in Table – V.

Table V. Regression analysis of prediction equation of Sports Authority of India Training Centre Hockey Players in Southern India

<table>
<tr><th colspan="2" rowspan="2">Model</th><th colspan="2">Unstandardized Coefficients</th><th>Standardized Coefficients</th><th rowspan="2">Sig.</th><th rowspan="2">Partial Correlations</th><th rowspan="2">Collinearity Statistics</th></tr>
<tr><th>B</th><th>Std. Error</th><th>Beta</th></tr>
<tr><td rowspan="2">Step1</td><td>(Constant)</td><td>-17.416</td><td>2.726</td><td></td><td>.000</td><td></td><td></td></tr>
<tr><td>BHT</td><td>.007</td><td>.000</td><td>.632</td><td>.000</td><td>.669</td><td>.914</td></tr>
<tr><td rowspan="3">Step 2</td><td>(Constant)</td><td>-12.463</td><td>1.160</td><td></td><td>.000</td><td></td><td></td></tr>
<tr><td>BHT</td><td>.019</td><td>.000</td><td>.683</td><td>.000</td><td>.688</td><td>1.000</td></tr>
<tr><td>RHR</td><td>.088</td><td>.015</td><td>.237</td><td>.000</td><td>.312</td><td>.826</td></tr>
</table>

In the Table – V, the following regression equations were derived for playing ability of Hockey players with dependent variables.

Regression Equation in obtained scores from = CR

Playing Ability (CR) = -17.416 +0.019(BHT) +0.088(RHR)

C.R	Playing ability
BHT	Breath holding time
RHR	Resting heart rate

The regression equation for the prediction of playing ability in hockey includes breath holding time and resting heart rate. As the multiple correlations on Hockey playing ability with the combined effect of these independent variables are highly significant, it is apparent that the obtained regression equation has a high predictive validity.

Conclusion

1. The results revealed that an Inter – relationship exists significantly between the physiological variables among hockey players.
2. The regression equation developed by two variables can be put in to prediction equation of hockey players.
3. The results revealed that the breath holding time and resting heart rate become the common characteristics which can predict the Hockey playing ability among hockey players.

Reference

1. Ananda Kumar. D. (2006). *Effect of specific drills on selected skill related fitness variables and skill performance among hockey players.* Unpublished Masters Thesis, Bharathiar University.
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Prediction of Playing Ability from Selected Physical Fitness Variables among Sports Authority of India Training Centre Hockey Players in Southern India

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Abstract

The purpose of the study was to predict the hockey playing ability from selected physical fitness variables among Sports Authority of India Training Centre Hockey Players in Southern India. To achieve the purpose, one hundred and fifty men hockey players were selected from Sports Authority of India Training Centre, Southern India and their age ranged from 18 to 25 years. The subjects had the past playing experience of at least one year in hockey. In this study, the hockey playing ability was predicted from one hundred and fifty hockey players with the help of predictor variables such as the Physical fitness variables namely – Speed (50 Metre Run), Agility (Shuttle Run) and Endurance (Cooper's 12 Min Run). The playing ability which was taken as the performance factor was subjectively assessed by three qualified hockey coaches. The present study consisted of one dependent variable, namely playing ability of hockey players and three independent variables. Descriptive statistics and Pearson's correlation coefficients were applied to establish the relationships among the variables measured. The computation of multiple regressions was also used. In multiple regressions, a criterion variable from a set of predictors was predicted. Step wise argument methods of multiple regressions were used in this study to find out the predictor variable that had the highest correlation with the criterion variables entered in the equation depending on the contribution of each predictor. The results revealed that the endurance and speed become the common characteristics which can predict the Hockey playing ability among hockey players.

Keywords: Physical Variables, SAI, Hockey Players, Southern India.

Introduction

Modern day hockey requires that players who wish to require the sport seriously realize the importance of fitness (Vimalnat, 2012). Within the past there has been an excessive amount of play in reference to preparation. Preparation includes improving skills, tactical understanding and fitness. Fitness must be checked out as quite running and a couple of exercises; fitness training has got to be seen as an ongoing planned a part of a player's preparation. Training is weakened into two parts: pre session and through the session. Scientific measurement of the results of teaching has a longtime place within the field of education today. However, reliable and valid tests of ability and achievement in education activities are so far comparatively few. A battery of tests for any game, if it were valid index of playing ability could be useful in several ways. It'd be utilized in classifying players, in determining progress in skill, in providing an incentive to practice, and in judging a teacher's efficiency (Ananda Kumar, 2006).

Materials and Methods

The purpose of the study was to predict the hockey playing ability from selected physical fitness variables among Sports Authority of India Training Centre Hockey Players in Southern India. To achieve the purpose, one hundred and fifty men hockey players were selected from Sports Authority of India Training Centre, Southern India and their age ranged from 18 to 25 years. The subjects had the past playing experience of at least one year in hockey. In this study, the hockey playing ability was predicted from one hundred and fifty hockey players with the help of predictor variables such as the Physical fitness variables namely – Speed (50 Metre Run), Agility (Shuttle Run) and Endurance (Cooper's 12 Min Run). The playing ability which was taken as the performance factor was subjectively assessed by three qualified hockey coaches. The present study consisted of one dependent variable, namely playing ability of hockey players and three independent variables. Descriptive statistics and Pearson's correlation coefficients were applied to establish the relationships among the variables measured. The computation of multiple regressions was also used. In multiple regressions, a criterion variable from a set of predictors was predicted. Step wise argument methods of multiple regressions were used in this study to find out the predictor variable that had the highest correlation with the criterion variables entered in the equation depending on the contribution of each predictor.

Results

Table I. Correlation Matrix of Playing Ability with selected physical fitness variables among Sports Authority of India Training Centre Hockey Players in Southern India

	SPE	AGI	END	PA
SPE	1	0.475**	0.108	0.252**
AGI		1	0.016	0.279**
END			1	0.554*

*Significant at 0.05 level ** Significant at the 0.01 level

Table II. Descriptive statistics of selected physical fitness variables among Sports Authority of India Training Centre Hockey Players in Southern India

S.No	Variables	Minimum	Maximum	Range	Mean	SD (±)
1	Speed	7.19	8.01	0.82	7.53	0.24
2	Agility	11.17	12.49	1.32	11.82	0.40
3	Endurance	2104.00	2397.00	293.00	2236.60	87.98
4	Playing Ability	6.00	9.00	3.00	7.06	1.02

Table – I showed the descriptive statistics –Minimum, Maximum, Range, Mean and Standard deviation of selected physical fitness variables and the playing ability. The present study attempted to link the coaches rating as measure of playing ability in hockey from selected physical fitness variables among hockey Players.

Table III. Analysis of variance for the influence of independent variables on playing ability among Sports Authority of India Training Centre Hockey Players in Southern India

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	92.230	1	92.230	209.66*	.000[b]
	Residual	65.103	148	0.440		
	Total	157.333	149			
2	Regression	98.479	2	49.239	122.98*	.000[c]
	Residual	58.854	147	0.400		
	Total	157.333	149			

It was clear from the table – III that the obtained F value, 209.66 and 122.98 respectively were significant at 0.05 level. It revealed that two independent variables were collectively influenced on the playing ability in hockey. As the F ratio was significant, multiple regressions were computed. Multiple regression equation was computed only because the multiple correlations were sufficiently high to warrant prediction from it. Then, the correlation identified the independent variables to be included and their order in the regression equation. Multiple correlations were computed by step wise argument method on data of Hockey players and the results were presented in Table – IV.

Table IV. Step wise multiple regression between playing ability in hockey and independent variables among Sports Authority of India Training Centre Hockey Players in Southern India

Model	Variables	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	Endurance	.980[a]	.961	.959	.20825
2	Speed	.981[b]	.962	.960	.20606

From Table – IV, it was found out that the multiple correlations co – efficient for predictors, such as endurance and speed was 0.981 which produced highest multiple correlations with hockey playing ability. ‘R’ square values showed that the percentage of contribution of predictors to the Hockey playing ability (Dependent variables) is in the following order.

1. About 98% of the variation of playing ability in hockey was explained by the regression model with two predictor endurance and speed.

   Multiple regression equation was computed and the results were presented in Table – V.

Table V. Regression analysis of prediction equation of Sports Authority of India Training Centre Hockey Players in Southern India

Model		Unstandardized Coefficients		Standardized Coefficients	Sig.	Partial Correlations	Collinearity Statistics
		B	Std. Error	Beta			
Step1	(Constant)	11.850	.533		.000		
	END	3.991	.071	.954	.000	.954	1.000
Step 2	(Constant)	- 11.394	.512		.000		
	END	3.675	.073	.881	.000	.944	.765
	SPE	-.018	.001	.150	.000	.438	.765

In the Table – V, the following regression equations were derived for playing ability of Hockey players with dependent variables.

Regression Equation in obtained scores from = CR

Playing Ability (CR) = 11.850 +3.675(END) -0.018(SPE)

C.R	Playing ability
END	Endurance
SPE	Speed

The regression equation for the prediction of playing ability in hockey includes endurance and speed. As the multiple correlations on Hockey playing ability with the combined effect of these independent variables are highly significant, it is apparent that the obtained regression equation has a high predictive validity.

Conclusion

1. The results revealed that an Inter – relationship exists significantly between the physical fitness variables among hockey players.
2. The regression equation developed by two variables can be put in to prediction equation of hockey players.
3. The results revealed that the endurance and speed become the common characteristics which can predict the Hockey playing ability among hockey players.

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Contents

Measuring Research Trends of Physical Education Department PhD Thesis Titles using Text Mining Technique

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Abstract :

In India Physical Education was taught for over hundred years as a subject in colleges and universities, which was classified and placed under major subject Education. Research in Physical Education flourished in India from 1972. The research trends in Physical Education subject for past ten years in Tamil Nadu Physical Education and Sports University (TNPESU) was not measured. Hence this study was carried out to find out the research trends in physical education. The PhD research thesis Titles awarded by TNPESU in Physical Education Department from 2009-2019 ten years was selected as data for this study. The thesis titles words grouped into four main categories namely type of research, core/interdisciplinary subject, variables selected and type of subject choices for study. A total of 209 research topics were analyzed for this study and the inferences were drawn. From the analysis it was found that 158(75.60%) research topics are found to be experimental research in which 96(60.75%) research are sports training methods based research which is core of physical education subject. Majority of the research selected physical, physiological and psychological variables. Fifty five percent of research scholars chose players as their subjects and the rest of 45% chose school, college, obese, students for their study. Therefore form this study the research trend for past ten years was mapped and presented.

Keywords :

Ph D Thesis Titles, Physical Education, Research Trends, Text Mining

1. Introduction :

Physical Education is a branch of Education subject which was taught for over hundred years in India. The main focus of this subject is to improve the health of the educator as well as the student community. Research and advancement in many subjects takes place all over the world. The trend of research in a specific field is measured now and then, to know the area of research focused by the scholars and to know the dealt research in a particular subject. This will bring the trend of the research happening in a particular subject. Thereby the scholar community shall avoid duplication of study and concentrate on the new area where real problems may be identified and scientific research solutions be complimented. To know the research trend of Physical Education in TNPESU this study is initiated. No such study was carried out for past ten years.

The prime aim/objective of higher education institutions is to do teaching, research and to provide extension works. The second foremost duty of Higher Education Institutions is to undergo research. Research publications, research projects, Impact of research of particular authors affiliated to a particular HEI's brings an image to that particular institute. Hence NIRF, NAAC gives highest importance to the above said activities. Therefore HEI's are in a competitive academic community and working hard in their specific subjects to achieve maximum score in that competition. Supervisors and scholars are struggling to publish research works in highly indexed Journals.

Librarians and academic professionals collect the data from the indexing journal database and publish articles revealing which topic is predominantly published in a particular journal over a period of time. This becomes hands on guide to new scholars to find appropriate new topic for their research.

Such an attempt has been initiated to know the research trends of physical education in TNPESU. To proceed further past published literatures have been reviewed by the author to know the ways and means of measuring the research trends in other subjects. The literatures reviewed for this study is presented by the author in review of literature part.

2. Review of literature :

Scalfani (2017) Published a work by analyzing ten thousand chemistry thesis and dissertation titles from 1911-2015. He has collected data from nine research universities in United States. The collected texts were analyzed using MATLAB. Text mining options was used in MATLAB to analyse the data. A total of 9,684 titles was included for this study and it was found that a total of 115,008 words and 12,886 unique words. The author has limited his study to 100 unique words to draw inference. The author has found frequency of bigram word and trigram word and also found most commonly used words. The author also compared the year with frequency of words used during a particular period. From this study the author has found that in thesis titles words like synthesis, spectra, reaction, application, maces spectra and nuclear magnetic resonance were most commonly used by the students and scholars.

Nagarkar(2015) in his article measured the word Information Science/Library Science published in Web of Science database Indexed Journals from 1999-2013. The author's main focus is to adopt text mining concepts and to measure the major country, institutions, departments and individual contributing to information science/ library science. The author used Excel, Pajek, VOS Viewer to analyse the data retrieved from Web of Science database. From this study the authors revealed Chen & Friedman as the most prolific authors, USA the highest number of articles contributing country in Information Science/Library Science. And in Journal of American Medical Informatics highest number of articles being published related to the choose word.

Derysdale (2013) have undergone a study on blended learning research topics and analyzed 205 research topics for this study. This study was initiated to find the trend of blended learning research topics. The authors divided the topics into nine major topics with sub-topics. In this paper the authors have identified the patterns of research in blended learning. The authors highlighted the research carried out and the research gap available, which becomes a tool for further researchers.

3. Scope :

For this study the author has reviewed the above specified literatures. From the literatures the author has found that mapping of PhD research topics in specific subjects is in practice. And the author has decided to find the research trend in Physical Education subject. Hence this study is initiated to know the research trend in Physical Education.

4. Objectives :

The main objectives of this study are :

I. Which words are frequently used in Physical Education research thesis topics.

II. Which type of research design the scholars mostly choose for their study.

III. Which area in Physical Education/Interdisciplinary subjects identified as experimenting technique to pursue the research.

IV. Which variables research scholars mostly select for their study.

V. Which group of people predominantly selected as subjects for research.

5. Methodology :

TNPESU offers PhD programme in Physical Education from 2007 onwards under Teacher Education Faculty. The PhD degrees were awarded from the year 2009-2019. For this study he research topics submitted to this University for ten years was selected as data. A total of 209 thesis topics collected and the topics word separated using Excel. Therefore n=209. The separated words file was analyzed using Voyant tools online. The methodology adopted to analyse the file is Voyant tool online analyzing method. The analyzed data is presented in results and discussion part. The author have excluded certain words namely Determiners (a, an, the, its), Prepositions (on, at, with, among) and Conjunction (and, for) Words and used only the words which implies the research meanings.

6. Results and discussion :

A total of 209 research topics which was awarded by TNPESU from 2009-2019 was selected for analysis. The selected topics separated into individual words in excel using comma separated value. And the .csv file analyzed using Voyant Tools from the analysis the following results were drawn and the inferences was arrived.

From table 1, it was found that research scholars coined their research topics using a total of 3874 words counted from 209 topics. In which 2823 words are physical education related scientific terms and remaining 1051 words are Conjunctions, Determiners and Prepositions. From the table it is summarized that 561 distinct terms, 541 unique words and 321 single occurrence terms are used to present the research topics. The vocabulary density is found to be 0.215. From the table-1 it was inferred that 72.87% (2823) of terms are scientific in nature. Hence these terms alone used to find the research trends in Physical Education.

Table 1: Physical education Ph D thesis titles words total count

Sl.no.	Words	Total
1	Total Words	3874
2	Scientific Words Used for Topics	2823 (72.87%)
3	Determiners, Prepositions, Conjunctions Words	1051 (27.13%)
4	Distinct Words	561
5	Unique Words	541
6	Single occurrence Words	321
7	Vocabulary Density	0.215

***Voyant tools analyzed data**

Table 2 shows most frequently used terms in PhD topics. In the table the author has restricted the frequent total count from 152 to 76. Therefore from the Table-2 it was found that the terms like Selected, Training, Variables, Physiological, Effect, Players and Physical were frequently used in the Physical Education Ph D research topics. The total counts are specified in the table.

Table 2: Most frequently used terms

Sl.no.	Frequently used terms	Total
1	Selected	152
2	Training	126
3	Variables	123
4	Physiological	89
5	Effect	83
6	Players	83
7	Physical	76

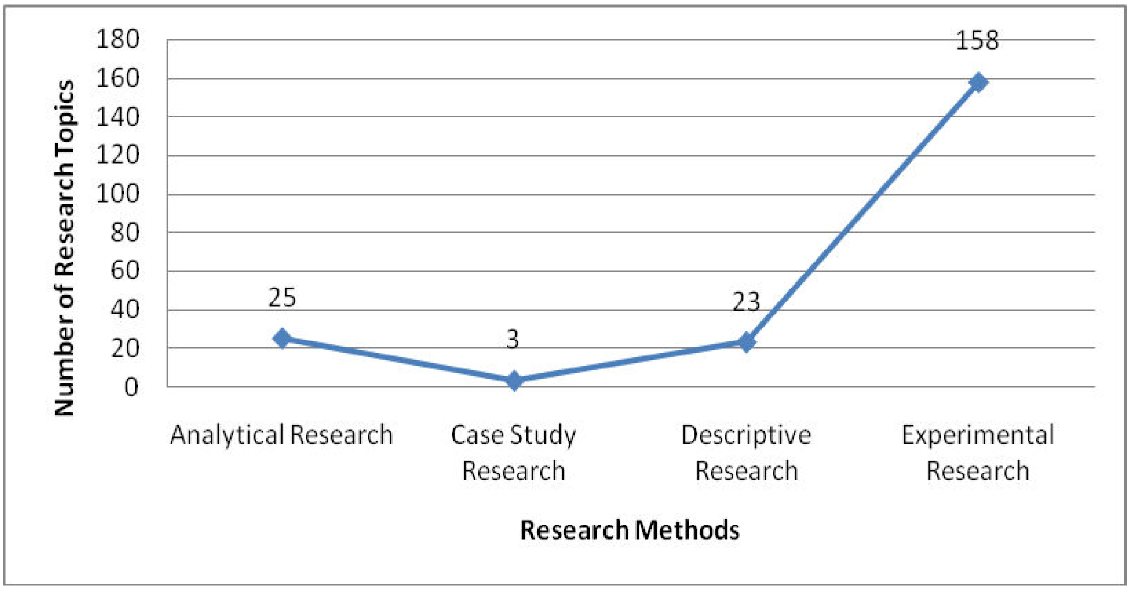
***Voyant tools analysed data**

To find the type of research methods adopted the author classified the research topics into four major categories of research methods. Among 209 research topics analyzed for this study it was found that 158(75.60%) topics belongs to Experimental Research methodology group which occupy first rank, 25(11.96%) topics belong to Analytical Research which occupy second rank, 23(11%) belong to Descriptive research and only 3(1.44%) are Case Study research methods. Hence from this table it was revealed that 75.60% of Physical Education research adopts Experimental research method techniques for their study. Followed by this 11.96% of PhD topics adopts Analytical research methods and 11% adopt Descriptive research method. Finally only one percent research adopted case study method.

Table 3: Type of research design adopted

Sl. no.	Research design	Total research count	Percent	Rank
1	Analytical Research	25	11.96	II
2	Case Study Research	3	1.44	IV
3	Descriptive Research	23	11.00	III
4	Experimental Research	158	75.60	I
		209	100	

Figure 1: Research methods adopted in physical education research



From the Figure-1 this is stated that most of the research carried out in Physical Education subject in TNPESU adopts Experimental research methods only. This shows that the Experimental research methodology is the trend which was adopted by majority (75.60%) of physical education researchers.

From table 4, it was found that which predominant area of physical education subject or interdisciplinary subject researchers selected as experimenting group. The table proves that 96 topics covers sports training methods groups, 21 yogic practices groups, 16 aerobics group, 12 exercise groups, etc. Among 158 experimental research methods topics 60.75% of the topics belongs to sports training methods groups, 13.29% belongs to yogic practices group, 10.13% aerobic group, 7.59% Exercise group. This shows that in Experimental research physical education scholars choose 83.54% core subjects as experimenting group and 16.46% Interdisciplinary subject as experimenting group.

Table 4: Area in physical education/interdisciplinary subjects identified as experimenting technique

Sl. No.	Experimenting technique	Total study	Core/Interdisciplinary	Percentage
1	Sports Training Methods	96	Core	60.75
2	Yogic Practices	21	Interdisciplinary	13.29
3	Aerobic	16	Core	10.13
4	Exercise	12	Core	7.59
5	Music	2	Interdisciplinary	1.27
6	Dance	3	Interdisciplinary	1.90
7	Learning	2	Core	1.27
8	Psychological	2	Core	1.27
9	Physical Fitness	4	Core	2.53
Total		158	Core-132 Interdisciplinary-26	100 Core = 83.54 Interdisciplinary =16.46

N=158

Also table 4A proves that among 158 Experimental study topics 45.57% of topics adopt two group designs which was found to be the predominant group choose for undergoing research. Followed by this 32.91% choose three group and 21.52% choose single group. The table-4A clearly predicts that in Physical education research selecting two experimental groups design is the trend of the research.

Table 4A : Experimenting technique groups

Sl. No.	Experimenting technique	Single group	Two group	Three group	Total
1	Sports Training	13	45	38	96
2	Yogic Practices	8	8	5	21
3	Aerobic	4	6	6	16
4	Exercise	2	9	1	12
5	Music		2	1	2
6	Dance		2	1	3
7	Learning	1		1	2
8	Psychological	2			2
9	Physical Fitness	4			4
		24(21.52%)	72(45.57%)	52(32.91%)	158

The Variables mostly selected by the research scholars is presented in Table-5. From the table it was found that research scholar's selected Physical variables 58(27.75%) followed by Psychological 56(26.79%), Physiological 50(23.92%), and Game Specific Sports Skills 32 (15.31%). Therefore the sequence of selecting variables is Physical, Psychological, Physiological and Game specific sports skills.

Table 5: Variables research scholars mostly selected

Sl. no.	Variables	No. of topics	Percentage
1	**Psychological** Biomotor-8 Motor-30 Psychomotor-5 Psychology-13	56	26.79

2	**Physical** Anthropometric-7 Physical-42 Fitness-4 Speed-3 Strength-2	58	27.75
3	**Exercise** Physiological-18 Health-13 Biochemical-2 Bodycomposition-3 Backpain-2 Lipid Profile-2 Liver-1 Lung-2 Cardiac-1 Metabolic-1 Morphological-1 Hematological-3 Musculoskeletal-1	50	23.92
4	**Biomechanics & Kinesiology**	3	1.43
5	**Game specific Skills & Performance** Skill-21 Performance-11	32	15.31
6	**Psycho-social**	1	0.48
7	**Learning**	4	1.92
8	**Case Study**	3	1.43
9	**Others**	2	0.97
		209	100

Finally to achieve the objective five of this study the author has collected the data pertaining to population or subjects selected in PhD research topics for undergoing the experiments. The predominant population selected is given in Table-6 and it was found that 116(55.50%) studies select various sports persons/players as their subjects which are found to be the predominant group, followed by this school boys and girls, College men and women, etc as their experimenting subjects.

Table 6 : Group of people predominantly selected as population/subjects for research

Sl. No.	Group of people		Total study	Percentage
1	Players		116	55.50
	Athletes	8		
	Ball Badminton	2		
	Basketball	15		
	Case study	2		
	Kho-kho	3		
	Kabaddi	4		
	Hockey	16		
	Handball	4		
	Cricket	7		
	Football	25		
	Volleyball	18		
	Players	9		
	Tennis	2		
	sociology	1		
		116		
2	School Boys and Girls		21	10.04
3	College Men and Women		27	12.92
4	Men and Women		9	4.30
5	Obese Students		9	4.30
6	Intellectually Challenged Children		5	2.39
7	Sedentary Men		5	2.39
8	Working Women		2	0.96
9	Information Technology Professionals		3	1.44
10	Police		2	0.96
11	Diabetes		2	0.96
12	Teaching Professionals		2	0.96
13	Others		2	0.96
14	Technical Officials		1	0.48
15	Labours		1	0.48
16	Juvenile Delinquents		1	0.48
17	Active Smokers		1	0.48
	Total		209	100

7. Conclusion :

Based on the results and discussions conclusions were drawn for this study. From the analysis the research trend of Physical Education is mapped and presented in conclusion. It was found that majority 158(75.60%) of research topics are found to be experimental research design based. Predominantly 132(83.54%) topics belongs to core experimenting techniques, such as sports training methods, exercise, aerobics, learning, physical fitness and psychology based research which is core of physical education subject. Rest 26(16.45%) of research are interdisciplinary in nature. Most of the research 72(45.57%) selected two groups. Majority of the research selected physical, physiological and psychological variables. Fifty four percent of research scholars choose players as their subjects and the rest of forty six percent choose school, college, obese, students for their study.

Since Physical Education imparts healthy way of life style and sports participation to youngster of this nation to achieve excellence in sports. The ultimate aim is to excel in sports. Indian youths are still lagging in excelling in International sports events. Therefore studies should come up in future to know the real problems faced by the entire sports industry and the real solution should be found and it should reach the needy person. It is suggested to the aspiring scholars to identify real problems faced by the people associated with sports and provide scientific solutions for those problems if possible reveal the secret to one and all in public domain thereby our nations dream will be fulfilled.

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A STUDY TO ANALYZE CORRELATION BETWEEN FEAR OF FALL AND ITS RISK FACTORS IN COMMUNITY-DWELLING OLDER ADULTS

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Background: *Older people who have suffered a fall are at increased risk of falling again. Falls are the leading cause of injury-related hospitalization in persons aged 65 years and over. Many factors were originally considered as possible risk factors for falls based on review of currently available literature. The aim of this study was to explore the relationship between fear of fall and risk factors of falls.*

Methodology: *This study included hundred older adults subjects, age 65 and above. They were asked to express their overall feel of fear of falling by Visual Analog Scale. Other risk factor variables are assessed and documented by Joint Position Sense test for Proprioception, Time Up and Go test for Functional Mobility, Sit and Reach test for Flexibility, Berg Balance Scale for Balance and Goniometric assessment for Ankle Range of Motion.*

Results: *The study reveals fear of falling has a strong negative correlation with balance (r -0.85, P<0.001), ankle dorsiflexion (r -0.54, -0.56, P<0.001), flexibility (r -0.52, P<0.001) and small negative correlation with ankle plantar flexion (r -0.28, P<0.05). The functional mobility and proprioception have a strong positive correlation (r 0.732, P<0.001) and moderate positive correlation (r 0.45, p<0.001) with fear of falling respectively.*

Conclusion: *This study concluded that the fear of fall in older adults is strongly associated with balance, flexibility, ankle range of motion, functional mobility and proprioception.*

Key Words: Fear of Falling, Older Adults

Introduction

Falls are the leading cause of injury-related hospitalization in persons aged 65 years and over, and account for 4% of all hospital admissions in this age group. In people over the age the age of 65 years, falls are the leading cause of death from injury. Falls also lead to substantial morbidity among older adults. Nearly 70% of all emergency department visits by people over the age of 75 years are related to falls. According to the World Health Organization (WHO) global report on falls prevention, people aged 65 years and above fall about 28%–35% in each year and this proportion increases as age and frailty level increase. The prevalence of falls in India, above the age of 60 years, reported to range 14%–53%.

Many factors were originally considered as possible risk factors for falls based on a review of currently available literature. These factors include age, number of chronic diseases. body composition, muscle strength, functional mobility and performance measures related to balancefunction.Impaired balance and functional mobility are major risk factors for falls. Since falls and its consequences have a major role in quality of life, rehabilitation programs, which aim to decrease the risk of falling by considering all contributing factors such as muscle strength, flexibility and balance, have the potential to both decrease the risk of falling and improve the quality of life.

Falls may be traumatic or non-traumatic. Even a fall without trauma has got a negative impact on the older adults and it sometimes instill fear of fall in them. In addition, falls may also lead to a post fall syndrome which includes dependency, loss of autonomy, confusion, immobilization, and depression, which will engender to a further restriction in daily activities. Overall, falls contribute to increase the risk of future fall thus affecting the quality of life. Due to this interaction, the relationship between fear of fall and its risk factors becomes significant. Based on a review of literature, this study was designed to explore the relationship between fear of fall and its risk factors (balance, functional mobility, proprioception, muscle strength, flexibility and fear of falling) in older adults.

Method

A total of 100 (53 men and 47 women) participants aged 65 or older with or without a history of falls were recruited from the various old age home near Cuddalore and houses of old age persons willing to participate in this study. Ambulatory individuals having no disability in self-care formed the population of this study and a report stating sound mental health was required at the registration of all participants.
The exclusion criteria were as follows: being aged less than 65, being unable to walk less than 10 meters, amputation, having had a stroke recently, unstable medical conditions, 2 or more fractures due to osteoporosis, resting angina, recurrent heart failure or recurrent arrhythmias and uncontrolled seizure disorder.

Procedure

Fear of fall by Visual Analog Scale: They were asked to express their overall feeling of fear of falling by drawing a mark on a vertical line of exactly 10 cm connecting the two statements ‘No Fear of Falling” (Below) and Very Afraid of Falling (Above). The score was the number of centimeters between No fear of falling and the subject’s mark.

Balance: The Berg Balance Scale (BBS) was used to evaluate balance. The BBS is a 14-item balance assessment tool that is scored on a 5 point ordinal scale (0–4) measuring levels of ability in performing each task (4 = safe and independent, 0 = incapable). The BBS includes tasks such as standing with eyes closed, reaching, standing on one foot and picking up objects from the floor. The highest total possible score on the Berg Balance Scale is 56, indicating excellent balance.

Functional mobility: The time up and go (TUG) test was used to measure basic functional mobility. The time taken to complete rising from chair, walking ten feet (3 meters), turning, walking back to the chair and sitting was recorded in seconds. The starting position was standardized so that the subjects commenced the test with their feet flat on the floor and their arm resting on arm rest. No physical assistance was given.

Flexibility: In order to assess flexibility, a sit and reach test was used. A box 32 cm in height and 50 cm in length with a top plate 45 cm in width was used for the test. The length of the top plate was 75 cm, the first 25 cm of which was extended over the front edge of the box towards the subject feet. Older adults were asked to sit keeping their knee straight, and reach forward as for as possible from a seated position. The score was determined by the furthest position they reached with their finger tips on a scale.

Ankle Range of Motion*:* Measurements of ankle dorsiflexion and plantar flexion were measured by goniometer in high sitting position.

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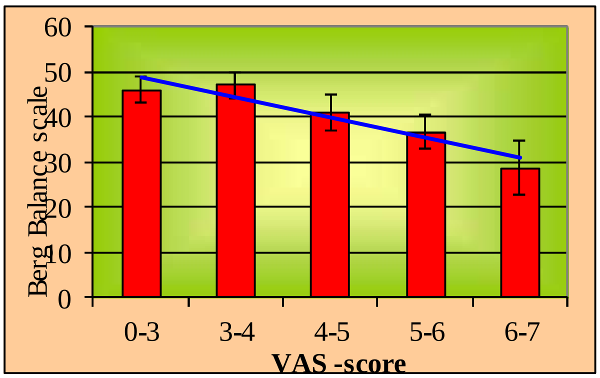
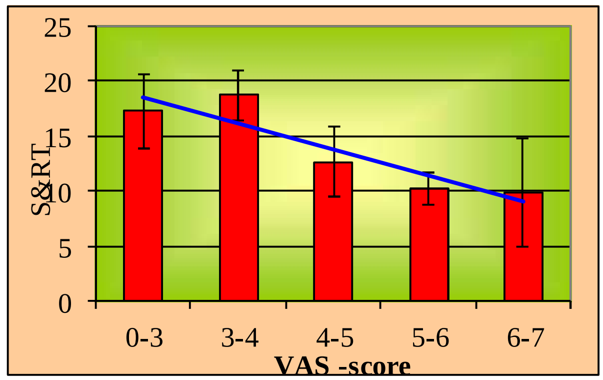
Proprioception*:* Proprioception was assessed using established and validated lower limb matching test. In this test subjects seated with their eyes closed were asked to align their lower limb simultaneously on either side of a vertical clear Acrylic Sheet (60X60X120) inscribed with a protractor and placed between their legs. To prevent limited motion at a knee joint from confounding the results of this test, the investigator ensures that the subjects matched their limbs near the midrange of knee joint motion. Any difference in aligning the lower limbs (indicated by disparities in matching the big toes on either side of Acrylic sheet) was measured in degrees for both extremities.

Data Analysis

Mean pattern of BBS in relation to Vas score



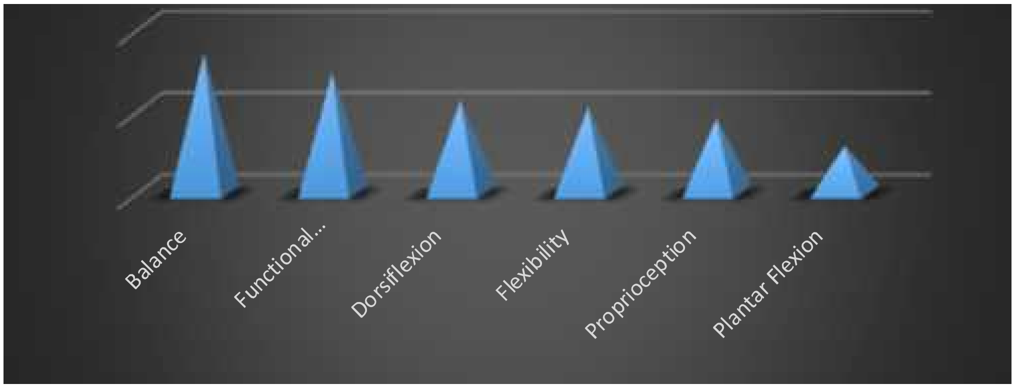
Mean pattern of S&RT in relation to Vas score



Study parameters	VAS score					P value
	0-3	3-4	4-5	5-6	6-7	
BBS	46.14 ±2.91	47.19 ±2.95	40.93 ±4.09	36.84 ±3.76	28.69 ±5.96	<0.001**
APF-Rt	29.00 ±2.23	29.75 ±2.52	23.89 ±3.15	22.19 ±2.61	19.38 ±2.16	<0.001**
APF-Lt	29.14 ±3.39	28.13 ±3.24	23.69 ±3.73	20.47 ±2.49	18.38 ±2.33	<0.001**
ADF-Rt	22.86 ±3.18	22.25 ±4.19	20.38 ±4.14	17.56 ±2.42	13.87 ±3.46	<0.001**
ADF-Lt	24.00 ±3.21	22.00 ±4.38	20.48 ±4.55	17.09 ±2.92	13.56 ±3.99	<0.001**
S&RT	17.30 ±3.41	18.72 ±2.22	12.68 ±3.25	10.25 ±1.46	9.83 ±4.84	<0.001**
TU&GT	12.29 ±0.49	12.69 ±1.07	15.86 ±3.97	19.29 ±3.56	22.32 ±2.86	<0.001**
Proprioception	7.71 ±0.49	5.75 ±1.00	4.66 ±1.26	4.47 ±1.27	3.94 ±0.77	<0.001**

Association of Study parameters in relation to Vas score. Results are presented in Mean ± SD

Relationship between Fear of fall and its risk factors



Discussion

In the current study, the ankle dorsiflexion had a large negative correlation (0.5-0.7) with fear of falling and that also been shown decreased ankle range of motion in both sex was found because of age related changes. The results suggest that, although all motions are important, compensation may occur when one motion in a plane is limited, particularly during gait. The lack of flexibility is associated with problems in executing and sustaining motor activities in daily life and is related to an increased risk of falling in older adults. According to current study the component of flexibility in male had a large negative correlation (0.5-0.7) and female had a very large negative correlation (0.7-0.9) with the fear of falling. Balance is one of the components required for execution of postural control. Balance capacity decreases with age, with results in increased risk of fall and fractures in elderly people. The results from this study shows that Berg Balance scores had a very large negative correlation with fear of falling. That is increase in the fear of fall scores with decrease in the Berg Balance Scale. In the current study, it has been found that fear of fall has a very large positive correlation with test (TUG). Proprioception is an important component of balance. Previous studies stated that proprioception does not correlate with quality of life. Whereas the current study revels proprioception had only moderate negative correlation with fear of fall.

Conclusion

The current study has shown the decline in balance, ankle range of motion, functional mobility and proprioception across the age decades. Thus, this study provides a tool for fall risk factor identification and provide valuable information for physician, therapists and other health care professional in both research and practice. There by the implication of this study is that Geriatric rehabilitation program should focus on the following risk factors of fall like balance, ankle range of motion, flexibility, functional mobility, and proprioception with greater importance on ankle range of motion and balance within older adults improve the quality of life and decrease the risk of falling in elderly.

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EFFICACY OF COMBINATION OF NATIONAL CADETS CORPS TRAINING AND PLYOMETRIC TRAINING ON SELECTED PHYSIOLOGICAL VARIABLES AMONG COLLEGE NCC STUDENTS

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ABSTRACT

The purpose of the study was to find out the efficacy of combination of National Cadets Corps training and plyometric training on selected physiological variables among College NCC students. To achieve this purpose, thirty male College NCC students were selected as subjects, their aged between 18 to 25 years; they are studying in the various college of Chennai, Tamilnadu. The selected subjects were divided into two equal groups of fifteen subjects each, namely Combination of National Cadets Corps training and plyometric training group and control group. The experimental group trained for three alternative days in a week for eight weeks with three sets per exercise per session at 60 to 80% with a progressive increase in load with the number of weeks. Physiological variables such as Breath holding time and Vital capacity were selected as criterion variables and they were tested by using Stop watch and Wet spirometer respectively. ANCOVA was used to find out the significant difference if any between the groups. The results of the study showed that there was a significant improvement on selected physiological variables such as breath holding time and vital capacity due to eight weeks of combination of National Cadets Corps training and plyometric training as compared to control group.

KEY WORDS: NATIONAL CADETS CORPS TRAINING, PLYOMETRIC TRAINING, BREATH HOLDING TIME AND VITAL CAPACITY.

INTRODUCTION

The youth of the country is a national asset and its development is a task of great significance and importance. The NCC has the expertise and built-in infrastructure to fulfill this mandate. Over the years NCC has contributed towards achieving this goal in an effective and meaningful manner. The National Cadet Corps (NCC) holds a golden key for all-round growth and transformation of our youth. What began in the year 1917, as the University Corps, after many changes and overhauls through the years, has come to be known as the National Cadet Corps (NCC) since November 1948. Today, with nearly 14 lakh cadets, both boys and girls, from over 13000 colleges and schools inclusive of those in remote and far flung areas, on its roll, the NCC is projected as the largest disciplined, uniformed youth organization in the world.

Plyometric training can take many forms, including jump training for the lower extremities and medicine ball exercises for the upper extremities. All the exercises are progressive in nature, with a range of

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low to high intensity in each type of exercises. Plyometric training is used for the lower body, upper body and core to enhance speed of movement in more specific skills. Plyometric training helps athletes learn greater balance, co-ordination, quickness, agility, speed and power.

Plyometric movements are performed in a wide spectrum of sports. In establishing the aim of plyometric training we must proceed from the definition of the general concept of training. We have stated that plyometric training is a means of achieving higher standard performances in athletics.

METHODLOGY

The purpose of the study was to find out the efficacy of combination of National Cadets Corps training and plyometric training on selected physiological variables among College NCC students. To achieve this purpose, thirty male College NCC students were selected as subjects, their aged between 18 to 25 years, they are studying in the various college of Chennai, Tamilnadu. The selected subjects were divided into two equal groups of fifteen subjects each, namely combination of National Cadets Corps training and plyometric training group and control group.

The selected subjects had undergone the Combination of National Cadets Corps training and plyometric training for eight weeks, with three days per week in alternate days. After 10 to 15 minutes of warm-up the subjects underwent National Cadets Corps training followed by plyometric training programme and the subjects performed Mark time march- 30beats/ 30 sec, Slow march- 70 paces/mints, Quick march- 120 paces/mints, Double march- 180 paces/mints for four weeks after that they performed four weeks of plyometric exercises 6 to 12 repetitions of plyometric exercises namely hopping, bounding, hurdles exercises, depth jumps, medicine ball throws, with a recovery distance of 20 to 40 meters or one to three minutes between repetitions. The control group did not participate in any specialized training during the period of study.

EXPERIMENTAL DESIGN AND STATISTICAL PROCEDURE

The experimental design used for the present investigation was random group design involving 30 subjects for training effect. Analysis of Covariance (ANCOVA) was used as a statistical technique to determine the significant difference, if any, existing between pretest and posttest data on selected dependent variables separately and presented in Table-I.

EXPERIMENTAL DESIGN AND ANALYSIS OF DATA

The experimental design used for the present investigation was random group design involving 30 subjects for training effect. Analysis of Covariance (ANCOVA) was used as a statistical technique to determine the significant difference, if any, existing between pretest and posttest data on selected dependent variables separately and presented in Table- I

TABLE – I

Variables	Test		Combination of NCC training and plyometric training Group	Control Group	Source of Variance	SS	df	Mean Square	'F' Ratio
Breath Holding Time	Pre test	Mean	40.13	40.96	Between	0.833	1	0.833	0.742
		S.D	4.191	2.95	Within	110.133	28	3.96	
	Post test	Mean	44.65	40.82	Between	19.20	1	19.20	22.049
		S.D	2.65	2.95	Within	123.6	28	4.86	
	Adjusted Post test	Mean	44.68	40.96	Between	26.72	1	26.72	27.64*
					Within	270.3	27	10.03	
Vital Capacity	Pre test	Mean	2408	2428	Between	3.33	1	3.33	1.33
		S.D	307.68	302.1	Within	648.53	28	23.162	
	Post test	Mean	2854	2434	Between	24.30	1	24.30	177.15
		S.D	260.90	305.54	Within	335.07	28	335.07	
	Adjusted Post test	Mean	2858	2432	Between	31.905	1	31.905	179.4*
					Within	708.53	27	40.02	

DISCUSSION

The result of the study indicates that the combination of National Cadets Corps training and plyometric training group had significantly improved the selected dependent variables namely breath holding time and vital capacity. However, control group did not show any improvement on the selected variables as it was not involved in any of the specific training means. The result of the study in consonance with the findings of plyometric training has produced significant improvement on breath holding time and vital capacity.

CONCLUSION

Based on the results of the study, it was concluded that

- There was a significance difference among combination of National Cadets Corps training and Plyometric training group and control group.

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- The results of the study revealed that there was a significant improvement on selected physiological variables such as breath holding time and vital capacity due to eight weeks of Combination of breath holding time and vital capacity.

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"EFFECT OF GAME SPECIFIC TRAINING ON SELECTED PHYSICAL AND PHYSIOLOGICAL VARIABLES AMONG COLLEGE LEVEL FOOTBALL PLAYERS"

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ABSTRACT

The purpose of the study was to determine the Effect of Game Specific Training on Selected Physical and Physiological variables among college level Football Players. To achieve this purpose, thirty men players were randomly selected from Chennai - Tamilnadu. The age of the subjects were ranged from 17 to 23 years. The selected subjects were divided into two groups such as Group – A was Experimental Group and Group – B was the Control Group. Each group consisting of 15 subjects. The experimental group underwent game specific training. The following criterion variables were selected for the physical variables namely, Speed, Agility and Leg Explosive Power and for the Physiological Variables such as Breadth Holding Time and Resting Heart Rate. The training period was 12 weeks except Saturdays and Sundays in every week. Data were collected from each subject before and after the 12 weeks of specific training. The collected data were statistically analyzed by using "t" Ratio. It was found that there is significant improvement in Speed, Agility and Leg explosive power due to the treatment of specific training. It was also found that there is significant improvement in Breath Holding Time and Resting Heart Rate due to the treatment of specific training.

Keywords*:* Game Specific Training, Physical Variables and Physiological Variables

INTRODUCTION: A sport is an organized, competitive, entertaining and skilful physical activity requiring commitment, strategy and fair play in which a winner can be defined by objective means. It is governed by a set of rules or customs. In sports the key factors are the physical capabilities and skills of the competitor when determining the outcome (winning or losing). Sports are most often played just for fun or for the simple fact that people need exercise to stay in good physical condition. However, professional sport is a major source of entertainment. While practices may vary, sports participants are expected to display good sportsmanship and observe standards of conduct such as being respectful of opponents and officials and congratulating the winner when losing (Douglas Harper, 2008).

TRAINING

Training is an educational process. People can learn new informations, re - learn and reinforce existing knowledge and skills, and most importantly have time to think and consider what new options can help them improve their effectiveness at work. Effective trainings convey relevant and useful information that inform participants and develop skills and behaviors that can be transferred back to the work place. The word 'Training' has been a part of human language since ancient times. It denotes the process of preparation for some task. This process invariably extends to a number of days and even months and years. The term 'Training' is widely used in sports. There is, however, some disagreement among sports coaches and also among sports scientists regarding the exact meaning of this word. Some experts, especially belonging to sports medicine, understand sport straining as basically doing physical exercises.

III. METHODOLOGY

The purpose of the present study was to determine the Effect of Specific Training on Selected Physical and Physiological Variables among College Level Men Football Players. To achieve this, thirty Men Football Players were randomly selected from Chennai Tamilnadu. The age of the subject ranged from 17 to23 years. The selected subjects were divided into two equal groups such as group - Group A was Experimental Group and Group - B was Control Group. Each group consisting of 15subjects. The Experimental Group underwent Game Specific Training. The following criterion variables were selected for the Physical Variables namely Speed, Agility and Leg Explosive Power and for the Physiological Variables such as Breathe Holding Time and Resting Heart Rate. The training period was for 12 weeks except on Saturdays and Sundays.

STATISTICAL TECHNIQUE

The following statistical procedure was employed to estimate the Effect of Specific Training on Selected Physical and Physiological Variables among College Level Men Football Players, 'T' Ratio was calculated to find out the significant of the difference between the mean of Pre and Post - Test of the groups.

RESULTS AND DISCUSSION

The data obtained on speed as a result of specific training were analyzed using the "t" Ratio and are presented in Table 2.

Table - 2
Table showing the Mean Difference, Standard Deviation and "T" Value of Control Group and Experimental Group on Speed

Variables	Group Name	Mean		SD		SD Error	'T' Ratio	Table Value
		Pre	Post	Pre	Post			
Speed	Control	6.85	6.86	0.14	0.17	0.04	0.98	2.15
	Experimental	6.83	6.42	0.13	0.19	0.04	9.02*	

Significance at 0.05 Level of Confidence

The Table 2 shows that the mean values of Pre - Test and Post - Test of Control Group in Speed were 6.85 and 6.86 respectively. The obtained 'T' ratio was 0.98 since the obtained 'T' ratio was less than the required table value is 2.15 for the significant at 0.05 levels with 14 degrees of freedom. It was found to be statistically insignificant. The mean values of Pre – Test and Post – Post of Experiment Groups in Speed were 6.83 and 6.42 respectively.

The obtained „t" ratio was 9.02 since the obtained 't' ratio was greater than the required table value of 2.15 for significance at 0.05 level with 14 degrees of freedom it was found to be statistically significant.The result of the study showed that there was a significant difference between control group and experimental group in speed. It may be concluded from the result of the study that experimental group improved in speed due to eight weeks of specific training.

The data obtained on agility as a result of game specific training was analyzed using the 't' ratio and are presented in table 3.

Table - 3
Table showing the Mean Difference, Standard Deviation and "T" value of Control Group and Experimental Group on Agility

Variables	Group Name	Mean		SD		SD Error	'T' Ratio	Table Value
		Pre	Post	Pre	Post			
Agility	Control	7.81	7.80	0.16	0.15	0.04	0.42	2.15
	Experimental	7.78	7.29	0.24	0.31	0.08	5.87*	

Significance at .05 level of Confidence

The Table 3 shows that the mean values of Pre - Test and Post - Test of Control Group in Agility were 7.81and 7.80 respectively. The obtained "t" ratio was 0.42 since the obtained "t" ratio was less than the required table 2.15 for the significant at 0.05 levels with 14 degrees of freedom. It was found to be statistically insignificant. The mean values of pre-test and post-test of experimental groups in agility were 7.78 and 7.29
Respectively.
The obtained "t" ratio was 5.86 sine the obtained "t" ratio was greater than the required table value of 2.15 for significance at 0.05 level with 14 degrees of freedom it was found to be statistically significant. The result of the study showed that there was a significant difference between Control Group and Experimental Group in Agility. It may be concluded from the result of the study that Experimental Group improved in agility due to12 weeks of specific training.

The data obtained on leg explosive power as a result of specific training were analyzed using the "t" ratio and are presented in table -IV.

Table - 4
Table Showing the Mean Difference, Standard Deviation and 'T' Value of Control Group and Experimental Group on Leg Explosive Power

Variables	Group Name	Mean		SD		SD Error	'T' Ratio	Table Value
		Pre	Post	Pre	Post			
Leg Explosive Power	Control	2.41	2.51	0.15	0.22	0.04	0.73	
	Experimental	2.38	2.69	0.10	0.17	0.03	3.06	2.15

Significance at .05 level of Confidence

The table IV shows that the mean values of Pre - Test and Post - Test of Control group in Leg Explosive Power were 2.41 and 2.51 respectively. The obtained "t" ratio was 0.73. Since the obtained "t" ratio was less than the required table 2.15 for the significant at 0.05 levels with 14 degrees of freedom. It was found to be statistically insignificant. The mean values of Pre - Test and Post - Test of Experimental Groups in Leg Explosive Power were 2.38 and 2.69 respectively.

The obtained "t" ratio was 3.06 since the obtained "t" ratio was greater than the required table value of 2.15 for significance at 0.05 level with 14 degrees of freedom it was found to be statistically significant .The result of the study showed that there was significant difference between Control Group and Experimental Group in Leg Explosive Power.

The data obtained on Breath holding Time as a result of specific training were analyzed using the 't' ratio and are presented in table -V.

Table - 5

Table Showing the Mean Difference, Standard Deviation and 'T' Value of Control Group and Experimental Group on Breath Holding Time

Variables	Group Name	Mean		SD		SD Error	'T' Ratio	Table Value
		Pre	Post	Pre	Post			
Breath Holding Time	Control	45.37	45.38	3.05	3.05	0.79	0.07	2.15
	Experimental	45.45	48.12	3.35	2.99	0.77	2.49*	

Significance at .05 level of Confidence

The table V shows that the mean values of Pre - Test and Post - Test of Control group in Breath Holding Time were 45.37 and 45.38 respectively. The obtained "t" ratio was 0.07. Since the obtained "t" ratio was less than the required table 2.15 for the significant at 0.05 levels with 14 degrees of freedom. It was found to be statistically insignificant. The mean values of Pre - Test and Post - Test of Experimental Groups in Breath Holding Time were 45.45 and 48.12 respectively.

The obtained "t" ratio was 2.49 since the obtained 't' ratio was greater than the required table value of 2.15for significance at 0.05 level With 14 degrees of freedom it was found to be statistically significant .The result of the study showed that there was a significant difference between Control Group and Experimental Group in Breath Holding Time .

The data obtained on resting heart rate as a result of specific training were analyzed using the 'T' ratio and are presented in table 6.

Table - 6

Table Showing the Mean Difference, Standard Deviation and 'T' Value of Control Group and Experimental Group on Resting Heart Rate

Variables	Group Name	Mean		SD		SD Error	'T' Ratio	Table Value
		Pre	Post	Pre	Post			
Resting Heart Rate	Control	75.60	75.27	2.87	2.81	0.73	0.81	**2.15**
	Experimental	74.80	72.67	2.46	2.44	0.63	2.96*	

Significance at .05 level of Confidence

The table VI shows that the mean values of Pre - Test and Post - Test of Control Group in Resting Heart Rate were 75.60 and 75.27 respectively. The obtained 't' ratio was 0.81 since the obtained "t" ratio was less than the required table 2.15 for the significant at 0.05 levels with 14 degrees of freedom. It was found to be statistically insignificant. The mean values of Pre - Test and Post - Test of Experimental Group in Resting Heart Rate were 74.80 and 72.67 respectively.

The obtained "t" ratio was 2.96 since the obtained "t" ratio was greater than the required table value of 2.15 for significance at 0.05 level With 14 degrees of freedom it was found to be statistically significant. The result of the study showed that there was a significant difference between Control Group and Experimental Group in Resting Heart Rate in. It may be concluded from the result of the study that Experimental Group improved in Resting Heart rate due to 12 weeks of specific training.

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DISCUSSIONS ON FINDINGS

The result of the study indicates that the Experimental Group namely Specific training group had significantly improved the selected Physical & Physiological Variables, when compared to the Control Group. It is also found that the improvement caused due to Game Specific training when compared to the Control Group.

CONCLUSIONS

1. The results of the study showed that there were significant improvements in Physical Variables on Speed, Agility and Leg Explosive Power after 12 weeks of Specific Training among College Men Football Players.
2. The results of the study showed that there were significant improvements in Physiological Variables on Breath Holding Time and Resting Heart Rate after 12 weeks of specific training among College Men Football Players.

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CHANGES ON SELECTED MOTOR FITNESS COMPONENTS IN RESPONSE TO COMBINATION OF AEROBIC AND ANAEROBIC TRAINING AMONG COLLEGE NCC STUDENTS

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ABSTRACT

The purpose of the study was to find out the changes on selected motor fitness components in response to combination of aerobic and anaerobic training among College NCC students. To achieve this purpose, thirty male players were selected as subjects, their aged between 18 to 25 years, they are studying in the various college of Chennai, Tamilnadu. The selected subjects were divided into two equal groups of fifteen subjects each, namely combination of aerobic and anaerobic training group and control group. The aerobic and anaerobic training group trained for combination of aerobic and anaerobic exercises three sets per exercise per session at 60 to 80% with a progressive increase in load with the number of weeks. Strength endurance and agility were selected as criterion variables and they were tested by using sit-ups and shuttle run respectively. ANCOVA was used to find out the significant difference if any between the groups. The results of the study showed that there was a significant difference on strength endurance and agility between combination of aerobic and anaerobic training group and control group.

KEY WORDS: AEROBIC TRAINING, ANAEROBIC TRAINING, MOTOR FITNESS, STRENGTH ENDURANCE, AGILITY.

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INTRODUCTION

The youth of the country is a national asset and its development is a task of great significance and importance. The NCC has the expertise and built-in infrastructure to fulfill this mandate. Over the years NCC has contributed towards achieving this goal in an effective and meaningful manner. The National Cadet Corps (NCC) holds a golden key for all-round growth and transformation of our youth. What began in the year 1917, as the University Corps, after many changes and overhauls through the years, has come to be known as the National Cadet Corps (NCC) since November 1948. Today, with nearly 14 lakh cadets, both boys and girls, from over 13000 colleges and schools inclusive of those in remote and far flung areas, on its roll, the NCC is projected as the largest disciplined, uniformed youth organization in the world.

Motor fitness is one of the components of the total fitness of the individual, which also includes mutual, social and emotional fitness. It is one of the basic requirements of life broadly speaking it means the ability to carryout our daily tasks without under fatigue.

Strength endurance is required in all sports movement, whether fast or slow, movements have to be done under lesser or higher conditions of fatigue. Agility is a combination of several athletic traits such as strength, reaction time, speed of movement, power and co-ordination. It's display becomes essential in such movements as dodging, zigzag running, stopping and starting and changing body positions quickly.

Plyometric is a method of developing explosive power, an important component of the athletic performance as plyometric movements are performed in a wide spectrum of sports. In badminton, it can be played more skillfully when players have the power that combines with strength and speed to develop explosive power for participating in various sports activities. The aerobic and anaerobic exercises improve significantly in developing motor fitness variables of the badminton players.

METHODOLOGY

The purpose of the study was to find out the changes on selected motor fitness components in response to combination of aerobic and anaerobic training among college NCC students. To achieve this purpose, thirty male college NCC students were selected as subjects, their aged between 18 to 25 years, they are studying in the various college of Chennai, Tamilnadu The selected subjects were divided into two equal groups of fifteen subjects each, namely combination of aerobic and anaerobic training group and control group. The selected subjects had undergone the combination of aerobic and anaerobic training for eight weeks, with three days per week in alternate days. After 10 to 15 minutes of warm-up the subjects underwent their respective three sets per exercise per session at 60 to 80% with a progressive increase in load with the number of weeks. The control group did not participate in any specialized training during the period of study. Strength endurance and agility were selected as criterion variables and they were tested by using sit-ups and shuttle run respectively. ANCOVA was used to find out the significant difference if any between the groups.

EXPERIMENTAL DESIGN AND STATISTICAL PROCEDURE

The experimental design used for the present investigation was random group design involving 30 subjects for training effect. Analysis of Covariance (ANCOVA) was used as a statistical technique to determine the significant difference, if any, existing between pretest and posttest data on selected dependent variables separately and presented in Table-I.

TABLE – I

Variables	**Test**		**Combination of Aerobic and Anaerobic Training Group**	**Control Group**	**Source of Variance**	**SS**	**df**	**Mean Square**	**'F' Ratio**
Strength Endurance	**Pre test**	**Mean**	47.00	47.27	**Between**	0.533	1	0.533	**0.112**
		S.D	1.93	2.40	**Within**	132.92	28	4.75	
	Post test	**Mean**	52.92	47.52	**Between**	218.700	1	218.7	**48.344**
		S.D	2.16	2.10	**Within**	126.67	28	4.53	
	Adjusted Post test	**Mean**	**52.94**	**47.52**	**Between**	233.785	1	233.785	**112.55**
					Within	56.081	27	2.077	

Agility	**Pre test**	**Mean**	10.93	10.99	**Between**	0.033	1	0.033	**0.742**
		S.D	0.252	0.162	**Within**	1.259	28	0.04495	
	Post test	**Mean**	10.73	10.96	**Between**	0.385	1	0.385	**22.049**
		S.D	0.123	0.141	**Within**	0.489	28	0.0175	
	Adjusted Post test	**Mean**	**10.73**	**10.96**	**Between**	0.336	1	0.336	**20.307**
					Within	0.446	27	0.01653	

RESULTS

The posttest mean of combination of aerobic and anaerobic training group and control group on strength endurance (52.92 ± 2.16 Vs 47.52 ± 2.10) resulted in a 'F' ratio of 48.344. The adjusted posttest mean of combination of aerobic and anaerobic training group and control group on strength endurance (52.94 Vs 47.52) resulted in a 'F' ratio of 112.55. The results of the study indicate that there was a significant difference between combination of aerobic and anaerobic training group and control group on strength endurance.

The posttest mean of combination of aerobic and anaerobic training group and control group on agility (10.73 ± 0.123 Vs 10.96 ± 0.141) resulted in a 'F' ratio of 22.049. The adjusted posttest mean of combination of aerobic and anaerobic training group and control group on agility (10.73 Vs 10.96) resulted in a 'F' ratio of 20.307. The results of the study indicate that there was a significant difference between combination of aerobic and anaerobic training group and control group on agility.

CONCLUSION

Based on the results of the study, it was concluded that the combination of aerobic and anaerobic training program has resulted in significant increase in selected motor fitness components such as strength endurance and agility.

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Hedonic Shopping Experience in Malls: A Scale Development Study

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ABSTRACT: The evolving retail sector, rising customer expectations and competitive landscape have emphasized the need for hedonic ingredients to enrich the shopping experience of consumers. Malls being a prime destination for hedonic shopping in India, this study aims to develop a practical hedonic shopping experience scale encapsulating the various types of hedonic experiences offered in malls. The study employed qualitative research using in-depth interviews to thoroughly investigate the shopping experiences of mall consumers and to generate the initial scale items. A structured questionnaire comprising these items was designed for the quantitative study. The data collected (n = 224) using mall intercept survey were subjected to exploratory and confirmatory factor analyses which yielded a 26-item hedonic shopping experience scale consisting of seven dimensions: window shopping experience, social experience, entertainment experience, gratifying experience, bargain shopping experience, status shopping experience and aesthetic experience. The potential applications of the proposed scale are discussed along with its limitations and directions for future research.

KEYWORDS: Shopping experience, Hedonic consumption, Malls, Scale development

I. INTRODUCTION

Shopping in India has witnessed a transformation with the evolution of the retail industry and specifically, the expansion of the organized retail sector. Shopping malls constitute a significant part of the Indian organised retail format which has developed dramatically in major tier 1 and tier 2 cities over the past decade (Pani, 2015; Dungarwal, 2016). Malls have revolutionized the shopping experience of consumers by influencing their shopping habits, preferences, and behaviour.

In the past, shopping was primarily about making need-based purchases. This can be termed as utilitarian shopping which is directed towards satisfying a functional or economic need and its value weighed on its success or completion (Holbrook and Hirschman 1982; Babin et al., 1994). Utilitarian shoppers are believed to be more task-oriented, efficient and rational who are concerned with 'expectations of consequences' i.e. means-ends type (Batra and Ahtola, 1991; Fiore and Kim, 2007). However, in recent times, consumers do not just shop for purchasing goods and services, but also for experiential and emotional reasons that go well beyond the traditional shopping paradigm. These multisensory, fantasy and emotive aspects of one's experience with products or services represent the hedonic consumption (Holbrook and Hirschman 1982). This hedonic view explores consumption experience not as a purely cognitive or information processing event, but via a phenomenological or experiential perspective.

Malls are the common destination for shoppertainment in urban India, which offer a wholesome shopping experience, specifically in the hedonic sense which includes shopping, entertainment and leisure. Visitors can not only purchase and consume various products and services, but the mall itself offers experiences which are consumable (Bloch et al., 1994). For the discerning modern consumers, malls are proving to be a panacea to all their shopping woes (Mohan and Tandon, 2015). Hence, malls have become increasingly popular among Indian consumers with an average weekday footfall of 30,000 - 50,000 that further spikes during weekends in case of the large city malls (Largest malls of India, 2013; Srivastava, 2017).

Despite the boom in mall culture and success stories of some popular malls, industry experts state that 60-90 percent of shopping malls in major cities across India are performing lamentably and face a bleak future owing to their non-adaptation and competition from new shopping malls offering sophisticated shopping experience to their customers (Khare and Rakesh, 2010; Shopping Malls dying in India, 2016; Survival Crisis, 2017). It is easier to get people to the mall once, but to get them to return and spend money depends on the mall's ability to offer hedonic shopping experience. Urban consumers in India and especially youth visit malls primarily for the hedonic shopping experience rather than just utilitarian purpose (Kaur and Singh, 2007). Most visitors are attracted to malls for varied experiential reasons such as aesthetics, luxury, safe environment, good ambience, entertainment, leisure, and best hang-out place for families and friends (Dungarwal, 2016). Malls which failed to offer such experiences have witnessed dipping footfalls and sales with some even forced to shut down (Shah and Bose, 2012; Nair and Maheshwari, 2017).

Since hedonic constituents have become the unique selling proposition of malls, it is essential to gain a comprehensive understanding of the hedonic shopping experience offered by malls to their consumers.

II. LITERATURE REVIEW

Shopping research in the past has generally focussed on the utilitarian aspects of the shopping experience, which are characterized as task-oriented and means-end type (Batra and Ahtola, 1991; Arnold and Reynolds, 2003). However, consumers are not just logical decision-makers who focus on functional benefits; they are also emotional human beings who are concerned with gaining hedonic experiences (Schmitt, 1999; Sadachar, 2014).

This shift from the traditional information processing approach to a more hedonic, experiential view of consumption was initially recognized by Tauber (1972) who found that shoppers have numerous psychological shopping motives other than just purchase of products and services. Holbrook and Hirschman (1982) presented the experiential view of consumption experience which emphasizes the importance of pleasure and happiness for a satisfying shopping experience. In a widely cited study, Pine and Gilmore (1999) proposed the concept of "Experience Economy" which contends that consumers are no longer interested in just purchasing goods and services; they desire engaging and entertaining experiences during shopping. They presented four dimensions of experience: educational, entertainment, escapist and esthetic experiences. Thus, to run a successful business in the retail space, retailers must offer enchanting shopping experiences that stimulate the consumers' senses and touch their hearts and minds (Pine and Gilmore, 1999; Sadachar, 2014).

Hedonic shopping experience in the context of malls

Past studies have highlighted the importance of hedonic attributes such as entertainment and leisure in drawing consumers to a mall. According to Bloch et al. (1994), malls are not just strictly purchase sites, but a centre for many hedonic activities. Wilhelm and Mottner (2005) found that consumers in developed countries prefer malls with experiential features rather than a typical status quo mall. Similarly, in recent times, Indian consumers largely shop from a hedonic perspective which involves getting product ideas, meeting friends, alleviating stress or breaking the monotony of everyday life (Kaur and Singh, 2007; Khare, 2011). Hence, urban Indian consumers desire to visit malls which offer an entertaining shopping experience (Srinivasan and Srivastava, 2010).

Recognizing the importance of hedonic aspect in retailing, most studies focused on incorporating it as one of the dimensions of various constructs such as consumer attitude (Batra and Ahtola, 1991), shopping value (Babin et al., 1994), shopping motivations (Tauber, 1972; Kaur and Singh, 2007; Farrag et al., 2010) and shopping orientations (Sinha, 2003). Very few studies concentrated on analyzing the shopping experience of consumers, specifically from the hedonic perspective. Pandey & Darji (2011) and Srinivasan & Srivastava (2010) qualitatively explored the concept of experience economy; while Sadachar et al. (2014) empirically examined the applicability of the 4Es (Pine and Gilmore, 1999) to understand the shopping experience of consumers in the context of Indian malls. These studies analyzed shopping experience within Pine and Gilmore’s Experiential Realms. Singh and Prashar (2013) analyzed the composition of shopping experience in the view of Dubai mall shoppers and they found that mall experience can be conceptualized as a mix of five factors i.e. ambience, physical infrastructure, marketing focus, convenience, and safety and security. In a similar study, Singh and Prashar (2014) explored the anatomy of shopping experience with respect to malls in Mumbai. They identified ambience, convenience, marketing focus, safety and security and physical infrastructure as the important components defining shopping experience.

It is a fact that with the evolving consumer expectations and competitive market, the composition of shopping experience offered by Indian malls has been changing. Also, the existing studies focus on the overall shopping experience and not specifically on the hedonic perspective. This necessitates the study of consumer perception of hedonic shopping experience offered in malls.

III. OBJECTIVE OF THE STUDY

Given the growing significance of hedonic experiences during mall shopping, this study aimed at investigating the hedonic shopping experiences of consumers in malls. Specifically, the objective of the study was to develop a scale representing the wide range of hedonic shopping experiences offered in malls.

IV. RESEARCH METHODOLOGY

To achieve the research objective, a qualitative study was conducted followed by a quantitative study involving exploratory factor analysis and confirmatory factor analysis to develop a scale summarizing the comprehensive range of hedonic shopping experiences in malls. In-depth interviews were conducted with regular mall going consumers as well as mall administrators to qualitatively explore the shopping experience of mall consumers. Based on these qualitative inputs and literature review, 42 scale items were generated which were validated by two marketing professors for content adequacy and representativeness. Finally, 37 items were retained after content validity.

A structured questionnaire was used as the data collection instrument for the quantitative study. The 37 items obtained from qualitative research was used to construct the questionnaire. The items were evaluated using the 5 point Likert scale (1 - strongly disagree and 5 - strongly agree). The sampling sites for the study were three prominent shopping malls in Chennai city, India. The data were collected using the mall intercept survey (Bush and Hair, 1985) where respondents were selected through convenience sampling technique. The respondents were asked to think about their shopping experiences in malls, the activities they indulged in while visiting malls and the feelings and level of satisfaction experienced during shopping. A total of 300 questionnaires were administered of which 224 filled questionnaires were found usable for further data analysis. The demographic analysis of the data revealed that the sample was diverse in terms of gender, age and income. It comprised approximately 41 percent men and 59 percent women between 18 to 60 years of age and varied income levels.

V. EXPLORATORY FACTOR ANALYSIS

The 37 items were subjected to exploratory factor analysis (EFA) using principal components method and varimax rotation to determine the number of distinct factors/dimensions and to categorize the generated items under these dimensions. A seven-factor solution was estimated and 6 items with factor loadings less than 0.5 were discarded for further iterations (Hair et al., 2006). The grouping of the items was examined for domain representation and 3 items were removed since they theoretically did not match other items in the factors they were grouped into. The remaining items were subjected to EFA which yielded a seven-factor solution with 26 items. The solution explained 63 percent of the total variance and the KMO measure of sampling adequacy of 0.762 indicated the fitness of data for factor analysis. The factor loadings ranged from 0.633 to 0.853. The Cronbach alpha coefficients, average variance extracted (AVE) and composite reliability (CR) estimates were above the prescribed threshold signifying good reliability and validity of the factor structure (Fornell and Larcker, 1981; Nunnally and Bernstein, 1994).

VI. CONFIRMATORY FACTOR ANALYSIS

The confirmatory factor analysis (CFA) was carried out for thorough examination of the scale's psychometric properties (Anderson and Gerbing, 1988). The 26 items obtained from EFA were subjected to CFA using maximum likelihood (ML) method in SPSS AMOS 22. The results revealed a 26-item seven-factor measurement model which was consistent with the EFA factor solution. The measurement model showed an adequate fit as the fit indices above the acceptable thresholds ($\chi2_{(303)} = 354.72$, $p = .001$; GFI = .901; AGFI = .875; CFI = .954; NFI = .823; IFI = 0.955; standardized RMR = .073; RMSEA = .035) indicating a good model fit with the data (Schermelleh-Engel et al., 2003; Vandenberg and Grelle, 2009). The CFA results showed that the standardized factor loadings of all items ranging from 0.558 to 0.859 were significant and above the prescribed limit of 0.5 (Hair et al., 2006). The item SMCs ranged from 0.312 to 0.738 and all modification indices were low and insignificant. Hence, no items were removed. Table 1 presents the 26-item factor structure obtained from the confirmatory factor analysis (Refer Appendix Figure A1 for the measurement model obtained from SPSS AMOS).

Table 1: Confirmatory Factor Analysis Results

Dimension	Items	Factor Loadings	Squared Multiple Correlations
Window shopping experience	This mall helps me explore the latest products/designs/brands available.	0.728	0.548
	I enjoy browsing and trying different products in this mall.	0.693	0.436
	Shopping in this mall keeps me up with the new fashion and trends.	0.698	0.437
	This mall offers the best window shopping experience.	0.621	0.428
Social experience	This mall is a great place to hang-out with family.	0.698	0.421
	I enjoy visiting this mall with my friends.	0.666	0.401
	This mall is the best place to socialize.	0.759	0.312
Entertainment experience	I enjoy visiting this mall since it has a variety of food and entertainment services.	0.699	0.738
	This mall offers first-class movie experience.	0.594	0.488
	This mall is entertaining with play areas, adventure games, health clubs and salons/spas.	0.611	0.535
	I like this mall as it is a one-stop destination for fashion, fun, food and films.	0.795	0.519
Gratifying experience	I visit this mall to break the monotony of my daily routine.	0.665	0.500
	Shopping in this mall feels like self-gratification for a hard day's work.	0.742	0.462
	When I am in a bad mood or stressed, I visit this mall to make me feel better.	0.680	0.550
	When I am alone and bored, this mall is a good place to go.	0.707	0.442
Bargain shopping experience	I like visiting this mall when there is an end of season sale or festive offers.	0.720	0.632
	I enjoy browsing different stores in this mall for good discounts.	0.731	0.374
	This mall is a convenient place to hunt for bargains.	0.699	0.352
Status shopping experience	Shopping in this mall is a sign of status and prestige.	0.859	0.488
	I prefer to shop in this mall just like my peers do.	0.558	0.576
	I feel more socially accepted when I visit this mall as my friends/colleagues do.	0.634	0.443
	Shopping in this mall helps make a good impression on others.	0.649	0.487
Aesthetic experience	I love shopping in this mall because of the artistic and pleasant interiors.	0.654	0.385
	The mall facilities (escalators, restrooms, parking) make the shopping experience convenient and pleasurable.	0.661	0.487
	I like the ambience (lighting, music, hygiene, aromas, and temperature) of this mall.	0.660	0.480

	I prefer this mall for shopping since it is peaceful and spacious.	0.740	0.530

Reliability and Validity

The scale reliability was assessed using composite reliability (CR) estimates. As shown in Table 2, CR values of the dimensions ranged from 0.751 to 0.792 which were above the prescribed limit of 0.7 (Fornell and Larcker, 1981; Nunnally and Bernstein, 1994). The convergent validity was examined using factor loadings and average variance extracted (AVE) estimates. The standardized factor loadings of all 24 items were significant and ranged from 0.558 to 0.859. As presented in Table 2, the AVE values of the dimensions ranged from 0.462 to 0.514 which were closer to the acceptable threshold of 0.4. Thus, the scale was considered to have adequate convergent validity (Fornell and Larcker, 1981; Hair et al., 2006). The discriminant validity was tested by comparing the AVE estimates of the dimensions and the correlations between them (Fornell and Larcker, 1981). As shown in Table 2, the AVE estimates of all dimensions ranging from 0.462 to 0.514 were greater than the squared correlation coefficients ranging from 0.00 to 0.269; hence the scale possessed adequate discriminant validity.

By analyzing the content of the items grouped together, the seven dimensions were labelled appropriately symbolizing the different hedonic shopping experiences offered in malls i.e. window shopping experience, social experience, entertainment experience, escapist experience, bargain shopping experience, status shopping experience and aesthetic experience. Table 2 presents the reliability and validity results obtained from confirmatory factor analysis.

Table 2: Confirmatory Factor Analysis - Reliability and Validity Results

Dimensions	**Composite Reliability**	**Discriminant Validity - Comparison of AVE and squared correlations**						
		WS	**SO**	**EE**	**GE**	**BS**	**SS**	**AE**
WS	0.780	**0.471**						
SO	0.751	0.078	**0.502**					
EE	0.772	0.003	0.173	**0.462**				
GE	0.792	0.206	0.269	0.120	**0.489**			
BS	0.760	0.015	0.061	0.004	0.027	**0.514**		
SS	0.774	0.000	0.023	0.008	0.004	0.000	**0.468**	
AE	0.774	0.179	0.007	0.031	0.019	0.091	0.004	**0.462**

*Note: Diagonal values in **bold** are AVE estimates and off-diagonal values are squared correlation coefficients*

WS-window shopping experience; SO-social experience; EE-entertainment experience; GE-Gratifying experience; BS-bargain shopping experience; SS-status shopping experience; AE-aesthetic experience

VII. RESULTS AND DISCUSSION

The data analysis yielded a reliable and valid scale for hedonic shopping experience with seven dimensions. Each of these hedonic experiences is discussed taking into account the qualitative study findings, theoretical background and literature.

1. Window shopping experience

The first dimension was labelled as 'window shopping experience' which consisted of items such as exploring latest products, trying different products and being up-to-date with new trends. Thus, window shopping experience refers to the feeling of pleasure obtained from browsing and examining various merchandise in a mall. During window shopping, consumers derive fun from exploring and seeking information, but they may not necessarily make a purchase. They regard the fashion updates they gain and the pleasure they experience from exploring as their main drive, irrespective of them making a purchase or not.

Tauber (1972) identified that learning about new trends is one of the personal shopping motives where people are interested in keeping track of the up-to-date trends in fashion and styling. This concept of window shopping/exploration corresponds with Arnold and Reynold's (2003) hedonic motivation of idea shopping which signifies shopping as a means to be cognizant with current vogue and popular designs and products. It is roughly similar to the 'educational experience' dimension of the 4Es concept (Pine and Gilmore, 1999) which comprises consumers' active participation with mind and/or body actively engaged to improve their skills and knowledge (Sadachar, 2014). Indian malls are generally focussed on captivating customers through shopping experience rather than educating them through events or classes. Since shopping is regarded as fun rather than an educational experience, this dimension is termed as window shopping which is one of the common hedonic experiences offered in malls.

2. Social experience

The second dimension was named as 'social experience' which consisted of items such as malls being a hang-out place for family and friends and a place to socialize offering good bonding experience. Thus, social experience refers to the pleasure derived from socializing with others. In urban India, malls have become a one-stop destination for shopping, fun and leisure. Hence, a majority of Indian consumers prefer mall as a happening and safe place to hang-out with family and friends. Malls have now become a desired place for working professionals to conduct unofficial business meetings, corporate events, lunch and dinner get-togethers and colleagues' birthday, promotion or farewell parties.

Malls are an expedient place for socialization which implies going out, meeting and hanging out with friends, family or colleagues. Past research has unearthed different shades of socialization while shopping. Stone (1954) first identified 'personalising' shopper as a distinct shopper type who tends to personalize and have close relationships with shop personnel. Tauber (1974) recognized the social motives of shopping i.e. having social experiences outside the home and communicating with other people. While these researchers solely focused on socializing with outsiders, Arnold and Reynold (2003) recognized social shopping as a hedonic motive which represents the pleasure of shopping with friends and family as well as bonding with outsiders. Social experience is a significant hedonic shopping experience desired by Indians since they are intrinsically embedded in their socio-cultural society characterized by social interdependence, deeper involvement with others and desire for social acceptance and support (Jacobson, 2004). Thus, malls are popular destinations to socialize and interact with others while shopping.

3. *Entertainment experience*

The third dimension was labelled as 'entertainment experience' which consisted of items such as malls offering a variety of food and entertainment services, movie experience and a one-stop place for fashion, food, fun and films. Thus, entertainment experience refers to the feeling of enjoyment and adventure derived from the various entertainment services such as movies, bowling alleys, video game arcades, kids' play areas and food courts offered in malls. Recent surveys found that nearly 50 percent of the mall visitors use entertainment services compared to a mere 20 percent who go shopping which emphasizes consumer preference for entertainment (Khare and Rakesh, 2010). Hence, all new-age malls are designed with a significant share of mall space for entertainment services to improve their customer footfalls and revenue.

Bloch et al. (1994), Anuradha and Manohar (2011) and Sadachar (2014) identified that the entertainment experience offered by mall services such as movies, cafes, food courts, arcades, health clubs, salon/spa, pubs and recreational services help attract consumer traffic to the malls. The hedonic motives of gaining enjoyment, fun and adventure have boosted the consumer demand for entertainment consumption (Sit et al., 2003). Hence, entertainment has now become a common hedonic shopping experience offered by malls.

4. Gratifying experience

The fourth dimension was identified as 'gratifying experience' which consisted of items such as visiting malls to break the monotony, self-gratification and to feel better. It refers to the pleasure obtained from recreation, relaxation and relief from the monotony of daily life. With the changing and demanding lifestyle, not many places offer both leisure and peace to people and malls are one such space which offers these along with shopping. For most people, mall atmosphere helps rejuvenate mood and shopping relieves stress. Thus, shopping in malls to gratify oneself is regarded as truly fun and stress buster.

The concept of gratification during shopping has been emphasized in past research. Hirschman (1983) introduced the escapism as one of the four hedonic behaviours to escape unpleasantness. Tauber (1972) was one of the first to recognize the self-gratifying benefits of shopping which are motivated not by the consumption value, but by the utility of the buying process. Similarly, Arnold and Reynolds (2003) found gratification as a hedonic shopping motive that helps alleviate stress, negative mood and as a way to unwind. Thus, malls offer a feeling of gratification which is a notable hedonic experience desired by customers.

5. Bargain shopping experience

The fifth dimension was labelled as ' bargain shopping experience' which consisted of items such as visiting mall for sale and offers, enjoy browsing for discounts and mall being a convenient place for bargain hunting. Thus, bargain shopping experience refers to the pleasure derived during the process of bargain hunting i.e. searching for sale, offers and best deals on purchases. Consumers in India rarely make purchases in malls since they are regarded as luxurious and expensive place for purchasing merchandise. However, in case of offers such as end-of-season sale and festive discounts, Indian consumers desire to visit malls, browse various stores and hunt for the best deals irrespective of them making a purchase.

The concept of pleasure from bargaining was formerly recognized by Tauber (1974) who posited that the ability to seek bargains makes one a sensible shopper. Similarly, Arnold and Reynolds (2003) identified value shopping as a hedonic motive which signifies customers' tendency to hunt for best deals at low prices. Though it can be contended that seeking bargains is a utilitarian behaviour, the process itself offers an adventure and emotional satisfaction which is inherently pleasure-driven or hedonic. Thus, malls can be regarded as a convenient spot with numerous shops and brands in one place to easily compare and hunt for bargains.

6. Status shopping experience

The sixth dimension was termed as 'status shopping experience' which consisted of items such as shopping in mall as a sign of status and prestige, to feel more socially accepted and to make a good impression. Thus, status shopping experience refers to the pleasure obtained from mall shopping owing to the status it confers. In this age, especially youngsters and middle class consumers who believe in display of wealth generally prefer shopping in malls since it is a matter of prestige. According to them, mall shopping enhances the way they are perceived by others and helps gain social approval. These conspicuous consumers buy some products and services in malls just as a status symbol to advertise how wealthy and classy they are.

Past studies have highlighted the significance of status-driven shopping and the proclivity of Indian consumers towards prestige over rationality while making purchases (Bullis, 1997; Kaur and Singh, 2007). Thus, malls offer pleasure through status shopping which is an intrinsic hedonic experience.

7. Aesthetic experience

The last dimension was labelled as 'aesthetic experience' which consisted of items such as mall ambience, interior design, architecture, facilities and spaciousness. Aesthetic experience refers to the pleasure obtained from the sensory appeal, comfort and opulence of the mall. In recent times, the rising customer expectations along with competitive market have compelled mall administrators to focus on mall atmospherics and customer service. Customers expect captivating and hygienic environment to make their shopping experience convenient and mesmerizing.

The concept of mall aesthetics has been highlighted in past research. Tauber (1972) recognized that sensory stimulation is one of the consumer shopping motives wherein the shopping environment may be an influencer of the consumer's decision to visit and shop in a store. Wakefield and Baker (1998) established that perceived physical environment of the mall is a vital determinant of consumers' excitement and desire to stay at the mall. According to Haytko and Baker (2004), physical comfort and atmospheric features of malls influenced the purchase patterns and favouritism of adolescent girls. Atmospherics comprising the mall interior design, layout, lighting, and music create an esthetic experience, which is one of the four experiential relams (4Es) identified by Pine and Gilmore (1999). Thus, aesthetic experience is one of the fundamental hedonic experiences that malls need to offer to improve the customer satisfaction and repatronage behaviour.

These seven types of hedonic shopping experiences were conceptualized and defined based on the qualitative study findings, review of literature and experts' opinion.

VIII. CONCLUSION

This study demonstrates the development of a practical hedonic shopping experience scale consisting of 26 items across seven types of hedonic shopping experience offered in malls. The hedonic experience dimensions are: window shopping experience, social experience, entertainment experience, gratifying experience, bargain shopping experience, status shopping experience and aesthetic experience.

For the scale development process, this study employed a qualitative study followed by a quantitative study consisting of data collection and analysis. In-depth interviews with mall consumers and administrators were conducted to qualitatively explore the various hedonic shopping experiences offered in malls. Initial scale items were generated using qualitative study results and literature review. A questionnaire consisting of these items were used for data collection through mall intercept survey. The data were subjected to exploratory and confirmatory factor analyses which yielded a 26-item seven-dimensional hedonic shopping experience scale with adequate reliability and validity.

IX. RESEARCH IMPLICATIONS

The hedonic shopping experience scale summarizes a wide range of hedonic experiences offered in malls which has a broad array of applications for researchers, retailers and mall administrators. The scale can function as a tool to measure the degree of hedonism offered by malls as perceived by its customers. This will indicate the extent to which the mall offers various hedonic shopping experiences. It can help the mall administrators in identifying the hedonic features prominently appealing to their customers and those missing in their mall. This information can facilitate in making better strategic and marketing decisions which include designing mall interiors, selection of retailers and entertainment services, allocation of mall resources and facilities.

The scale developed in this study can be used as a base to analyze hedonic experiences offered by other retail formats such as supermarkets, hypermarkets, grocery stores, e-tailers and street bazaars. Researchers and retailers can use this scale to test the level of hedonism provided by other retail settings. Based on the results indicating the customer perception of various hedonic experiences, the retailers can appropriately plan and strategize to improve their business model.

X. LIMITATIONS OF THE STUDY

The study has certain limitations which ought to be mentioned. First, the hedonic shopping experience scale is specific to malls in India. Hence, researchers and retailers must be cautious while applying the scale to other shopping contexts and regions. Secondly, the seven types of hedonic experiences are based on the qualitative research performed in this study which might not be the exhaustive list of hedonic shopping experiences offered in malls. Finally, the study was limited to Chennai city in India due to time and financial constraints. Besides, data was collected through mall intercept survey using convenience sampling which is a non-probability sampling technique. These limitations in terms of the sampling method affect the generalizability of results.

XI. FUTURE RESEARCH DIRECTIONS

This study provides considerable scope for future research. The hedonic shopping experience scale developed in this study can be further validated using a larger, geographically diverse sample for better generalizability of results. Besides, the applicability of the scale can be tested by adapting it for other retail formats such as supermarkets, hypermarkets, chain stores and e-tailers. In future, researchers can conduct an in-depth analysis of each of the hedonic shopping experiences found in this study. Further, the scale can be used to investigate the impact of various hedonic shopping experiences on customer satisfaction, loyalty and repatronage behaviour.

XII. APPENDIX

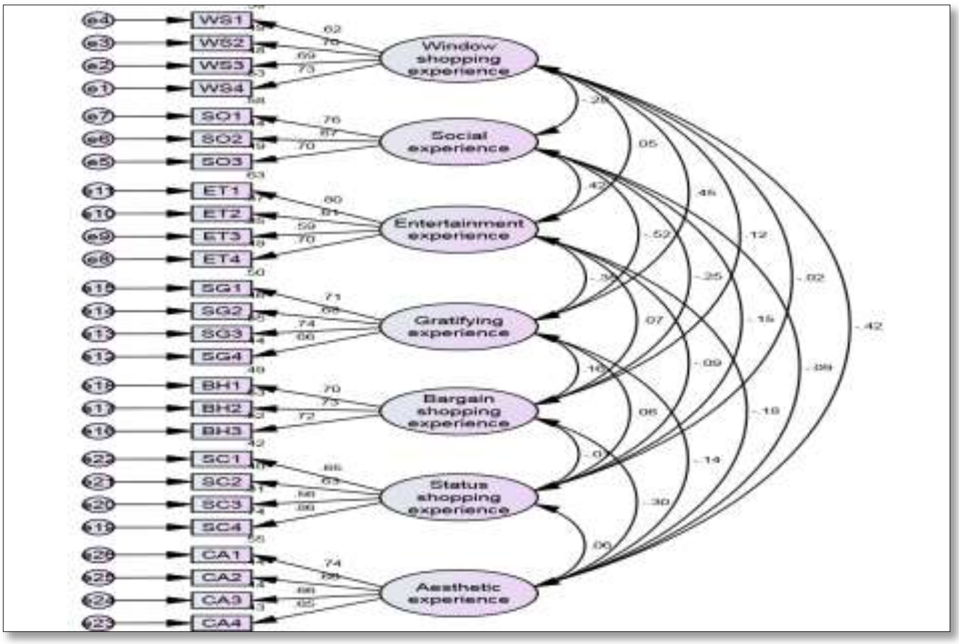

Figure A1 - Measurement Model from Confirmatory Factor Analysis

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Good Governance in National Olympic Committees (NOC) of SAARC Countries

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Abstract

This paper is concerned with the assessment of the governance and in particular, evaluating good governance in National Olympic Committees (NOC). For this study, a case study approached was adopted focusing on seven National Olympic Committees of SAARC (South Asian Association for Regional Cooperation) countries (India, Maldives, Nepal, Pakistan, Bangladesh, Bhutan, and Sri Lanka). The purpose of this study is to identify the gap if any in the governance of National Olympic Committees in SAARC countries and offer the basic set of recommendations on good governance practices. The researchers developed a questionnaire to evaluate the present level of governance of the organization and then to investigate what space among Olympic Committees in SAARC that has to be improved in parallel with the good governance theoretical framework. The review of literature collected for this study reveals that not much research were conducted in South Asian Countries in sports governance. The researchers used document analysis as a research method to examine the level of governance practices. Desktop research was conducted for the collection of the data for this study. The Organization's websites, statutes, internal regulations, and any other relevant available documents were analyzed thoroughly. Scoring took place based on publicly available data. The researcher used the Sports Governance Observer (SGO) as groundwork to measure governance in Olympic Committees in SAARC countries. The SGO survey is a combination of the four most important dimensions of the principles of good governance; transparency, democracy, checks and balances, and solidarity. The analysis has indicated that the results of football federations in SAARC countries on good governance are governed is not satisfactory. The average score and overall SGO index of Olympic Committees of SAARC countries are 2.46 and 36.4% respectively. Out of seven countries, India has the highest SGO index with 52.5 % whereas Nepal has the lowest with 30%. This overall score point indicates that NOCs in SAARC Countries have severe governance problems with transparency, checks and balances, and Solidarity. It has been significantly proved that the NOCs of SAARC countries need to put more efforts to further improve on the different dimensions of Good Governance.

Keywords: Governance, Transparency, Democratic Process, Checks and Balances, Solidarity.

Reference:

Geeraert, A. (2015). *Sports Governance Observer 2015: the legitimacy crisis in international sports governance*. Copenhagen: Play the Game.

1. INTRODUCTION

Corruption is nothing new in sports. The history of written corruption goes back to the Olympics in 338 BC, and the scandals of corruption over the past 20 years have confirmed that these problems are still relevant today (Maennig, 2002). Many notable corruption scandals include the vote-buying scandal over the Salt Lake City Olympic bid (Longman, 2000) and the decision to win gold medals at the same time as the 2002 Olympic Winter Games in a figure-skating in favor of the Russian duo and two Canadian contestants (Clarey, 2002), as well as systematic corruption among FIFA officials currently under investigation at the time of writing. The similarities between immorality and drug use are evident in the recent whistle-blowing scandal that plagued Russia and its drug rehabilitation program during (at least) the 2012 and 2014 Olympic Games (Ruiz, 2016). As a result, Olympic medals from fraudulent athletes from 2012 and 2014 have been canceled, and many Russian athletes were banned from the 2016 Olympics in Rio de Janeiro.

One of the purposes of good governance is to prevent corruption in a transparent manner, not to give a member of the board of government or an organization holding a potential reason or incentive to participate in the corrupt process. From an economic point of view, corruption can be caused if “the expected use of corrupt practices (large enough) on both sides to overcome any social decline” (Maennig, 2005, p. 205).

The challenge of a general good governance framework, including the code of conduct and rules of each relevant organization, to integrate the various priorities under the umbrella of independent management of sports federations. Besides, the management framework needs to uphold the ethical standards of the sport in general, which is why previous attempts to use existing checklists in principles of transparency, accountability, and integrity (as well as social responsibility) play an important role in creating a framework within which sport industry organizations can operate (Geeraert, 2016). It is important to clarify that these basic principles cannot be considered in isolation, as they are interrelated (Houlihan, 2013). Additionally, there are several other principles on how good governance can be done, as there are a variety of important topics for each organization.

The policy of transparency includes the opportunity to obtain relevant organizational information, clear external communications, and external audits and monitoring. Transparency is based on the individual ideology of democratic government, preventing corruption and the abuse of power in general (Geeraert, 2016); however, transparency does not happen in some of the leading sports organizations. Transparency requires a certain openness ("disclosure", commercially) of traditional closed corporations of external auditors and government audits. This is difficult to achieve because the same people are often involved in both the decision-making process and the management itself, even after the scandals of recent corruption (Chappelet, 2016).

2. RESEARCH METHODOLOGY

After reviewing various literatures, it was found that the research questions in this study were not fully answered by the current sports governance framework because there is insufficient theory or model showing the problems investigated in this study. The question in this research study is to find out the current level of good governance in the National Olympic Committees of SAARC countries. The researcher used textual analysis as a research method to assess the level of governance practices. The desktop study is for the collection of data for this study. The corporate websites, policies, internal regulations, and other relevant documents available were carefully analyzed. The calculation is based on publicly available data. Therefore, the researcher used an existing research tool for the Sports governance practices in SAARC National Olympic Committees. This testing tool is used in the South Asia Sport System since the NOCs in SAARC countries have similar structures and rules that make this measurement tool an appropriate tool.

The Sports Governance Observer (SGO) test tool was developed jointly by the Play the Game and Danish Institute for Sports Studies in 2012 and 2013, in partnership with six reputable European universities and the European Journalism Center. It is a self-assessment checklist for good governance in international sports organizations. The tool is also defined using a scoring system. Importantly, the Supervisor of Sports Management is based on the basic indicators of good governance. A thorough examination of good governance practices on ISFs requires in-depth research in some way. The existing and non-SGO checklists lists four factors that are considered to be the most important factors related to good governance in sport, including transparency, democratic process, checks and balances, and Solidarity. (Geeraert, 2015,) SGO research is a combination of the four most important values of good governance principles; each element contains an unequal number of indicators (36 in total), including transparency (12 indicators), democracy (10 indicators), checks and balances (7 indicators), and solidarity (7 indicators) . Each indicator is measured using the scales below:

1.	2.	3.	4.	5.
Not fulfilled at all	Weak	Moderate	Good	State of the art

The below SGO index formula will be used to synthesized and examined the survey scores:

$$SGO\ index_{fed\ x} = \frac{\left(\dfrac{\frac{\sum_{i=1}^{12} Trans_i}{12} + \frac{\sum_{j=1}^{10} Dem_j}{10} + \frac{\sum_{k=1}^{7} Check_k}{7} + \frac{\sum_{l=1}^{7} Sol_l}{7}}{4}\right) - 1}{4} \times 100$$

Table – 1

Sport Governance Observer Index and Sport Governance Observer Scores.

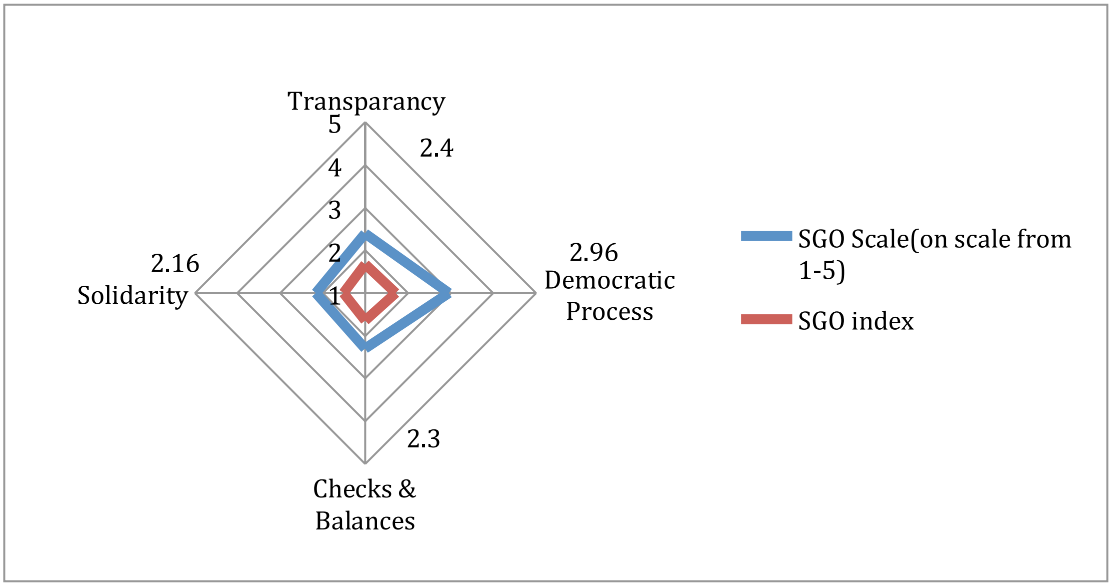
Sl.No	Countries/ Indicators		Transparency	Democratic Process	Checks & Balance	Solidarity	Average SGO scale & Index
1.	**Bangladesh**	**SGO Scale (on scale from 1-5)**	2.3	2.4	2.2	2	**2.23**
		SGO index	32.5%	35%	30%	25%	**30.63%%**
2.	**Bhutan**	**SGO Scale (on scale from 1-5)**	2.2	2.9	2.1	2.1	**2.33**
		SGO index	30%	47.5%	27.5%	27.5%	**33.13%**
3.	**India**	**SGO Scale (on scale from 1-5)**	2.5	3.7	3.3	2.9	**3.1**
		SGO index	37.5%	67.5%	57.5%	47.5%	**52.5%**
4.	**Maldives**	**SGO Scale (on scale from 1-5)**	2.3	3.1	2.2	2.1	**2.43**
		SGO index	32.5%	52.5%	30%	27.5%	**35.63%**
5.	**Nepal**	**SGO Scale (on scale from 1-5)**	2.1	2.9	2	1.8	**2.2**
		SGO index	27.5%	47.5%	25%	20%	**30%**
6.	**Pakistan**	**SGO Scale (on scale from 1-5)**	3	2.5	2	2	**2.37**
		SGO index	50%	37.5%	25%	25%	**34.38%**
7.	**Srilanka**	**SGO Scale (on scale from 1-5)**	2.4	3.2	2.3	2.2	**2.53**
		SGO index	35%	55%	32.5%	30%	**38.13%**
8.	**Mean of SGO Index of SAARC Countries**	**SGO Scale (on scale from 1-5)**	2.4	2.96	2.3	2.16	**2.46**
		SGO index	35%	48.92%	32.5%	29%	**36.4%**

3. RESULTS AND DISCUSSION

It is observed from the above table.1 that, the SGO index of SAARC National Olympic Committees is 36.4% collected from Transparency (35%), Democratic Process (48.92%), checks and balances (32.5%), and Solidarity (29%). This complete figure clearly shows that the National Olympic Committees of SAARC countries have serious administrative problems on all sides. Pakistan has the highest 3 SGO values with a 50% SGO index and Nepal has the lowest SGO rating at 2.1 with an SGO index of 27.5% respectively. India tops the Democratic Process with 3.7 and 67.5% SGO and SGO indicators respectively while Bangladesh has a low score of 2.4 SGO Score with a 35% SGO index. In Checks & Balances and Solidarity, India has the highest SGO on a scale of 3.3 and 2.9 respectively and the SGO index with 57.5% and 47.5%, while Nepal and Pakistan share the lowest scores with 2 SGO scores on the scale and 25% SGO index. Collectively, Nepal has the lowest points on the SGO scale and the SGO index with 1.8 and 20% respectively. Overall, India has the highest SGO rating of 3.1 with an SGO index of 52.5%, and Nepal with the lowest SGO rating of 2.2 with an SGO index of 30%. It is inferred that NOCs of SAARC countries' weak to moderate positions in all dimensions. Transparency (35%), Democratic Process (48.92%), Check and Balance (32.5%) and Solidarity (29%) calling for the organization to take extra effort to develop all areas. The mean value of SGO scale is represented in Figure.1.

Figure-1

Sport Governance Observer Result Chart: Olympic Committees of SAARC Region



4. CONCLUSION

The stakeholders of NOC need to have confidence that they are effectively and fairly governed at every level. To ensure this, the roles and responsibilities of all participants have to be clearly defined in the NOCs and the same to be communicated to each participant of the Olympic movement of the country besides making them know the significance of each dimension of good governance such as Transparency, Democratic Process, Check and Balance and Solidarity. Further, NOCs of SAARC countries need to have systematic good governance practices to take full advantage of organizational resources. The NOCs must have detailed medium and long-term plans for them as to how to go ahead of achieving good governance in the future. The task of achieving good governance is possible when the NOC itself is sound and strong, the NOC has adequate and good administration, and when the management of the NOC is well-organized and efficient. It is therefore suggested that NOCs of SAARC countries must take efforts to strengthen 1) the organizational structure 2) the administration and management to enable them to achieve good governance in the coming days.

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The Impact of Knowledge Management on Employees Productivity: The Case of Lebanon

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Abstract

Knowledge management nowadays had been considered as a main element for achieving organizational success and survival in today's knowledge age and competitive environments. The performance of the Lebanese Banking Sector nowadays is fluctuating, and the main reason behind that is the absence of knowledge management in the workplace and by that absence of communication among employees and managers in their workplace. The primary motivation which lies behind the research is to identify the importance of knowledge sharing, and how it affects employees' involvement and engagement in the workplace. The research had implemented both quantitative and qualitative methods, and the data were analyzed using both descriptive and inferential statistics to validate the research hypotheses scientifically. The findings of the research proved that there is a significant positive relationship between Knowledge enhancement, E-Learning, Knowledge management and organizational commitment.

Keywords: E-Learning, Knowledge Management, Knowledge Enhancement, and Organizational Commitment.

Introduction

Alavi and Leidner [1] claimed that many organizations are equipped with information management, which seeks to preserve, collect and disseminate knowledge throughout the enterprise in a world in which knowledge are increasingly regarded as the most critical resources of an organization. Kiantoet al. [2] has been proposed to inspire and empower skilled individuals to use and share their understandings and develop new knowledge, in large part in knowledge management to build, provide, encourage and support reasonable learning conditions in associations. Knowledge is in the form of intelligence, awareness, contextualization and thought, according to Davenport and Prusak [3]. It is a powerful form of data available for use in choices and events. Organizations will accurately see which knowledge gives them a handle. Wenger et al. [4] said the group would have a creative and concentrated advantage over knowledge or know-how. Knowledge has become a means of accomplishment. It is inherently unnecessary and impossible to be used as a weapon [5]. Despite its value and expertise, many organizations face difficulties in coping with the demands of the economy powered by learning. In many organizations, research institutions and various parts of the economy, the topic of information management is a moving subject today. Education has played a critical role in building and promoting monetary confidence among traditional assets of property, work and money. In the last decade, important work assessing information, like treatment, intellectual resources (human capital), society and the process over knowledge management have been recognized as critical factors, according to Wiig et al. [6]. The evaluation aims to provide a theoretical model of casework to improve the research administration by compellingly reconciling these considerations and making active use of knowledge properties. It will emphasize the integrative effect on information management of processes, academic (human), society and methodology.

An Overview of Knowledge Management

The absence of the information management concept (KM), continues to decline in the business community and that can be observed from the last decade of the twentieth century. The business world has seen the emergence of innovation in the new information-age system. The caring for vital and strategic expertise in the new knowledge ecosystem and its ongoing growth allow companies to generate additional benefits. Knowledge management has now been extended to various segments, universities, administrative, agencies, research, and development etc. (Lee, 2005) Pruzinsky et al. [7] also claimed that knowledge management is about how people trained can use and communicate their experiences to gain new experience and expertise. Pruzinsky et al. [8] explore whether and how knowledge management practices can be used in order to promote employee work satisfaction. Knowledge Management (KM) consists of a set of procedures for the development, dissemination and use of information in an entity [9]. As described in IFLA, KM is' a system in which authoritative knowledge is made (produced, captured) is placed out (protected, organized, coordinated) and used (imparted), used (implanted) and reused (changed) in order to enable an entity to achieve its objectives.' It involves formal information management and tacit knowledge sharing (i.e. skills/mastery / know-how) [10]. Of starters, within the group, minutes of meetings, resolutions, guidelines of notes, documentation, etc. and other records such as files, documents, government data, research papers are gathered inside organizations' associations and other material is retrieved. Tacit knowledge, though, integrated into the working people's brains through extensive knowledge of rules and regulations, job processes, etc. [11]. Tacit and specifically knowledge is considered to be the most important part of an organization's information, and the handling of which should be performed with the utmost care and should be the prime motive for all organizations [12].

According to Javed et al. [13], based on previous research, employees will be proactive, more creative, and innovative when they are satisfied with their work. They will do their job. Not many research studies on the management of information and job satisfaction to the organization were addressed, as mentioned by Pruzinsky et al. [14]. Therefore, while conducting Knowledge Management, the researcher intended to analyze job satisfaction in detail. Tsai [15] reveals that job efficiency can be improved if incremental fragments provide focal structures that enable the exposure of different divisions of an enterprise to new learning [15]. The relationship between KM and efficiency had been recognized with conspicuous inspection of facts, the management of knowledge, and its unique impact on employee performance [16]. Accordingly, Woods [17] mainly offers multinational organizations (MMC) and public offices and agencies for establishing and accepting information management in Malaysia. The insistence on improving information systems in their organizations has shown to be less on small-medium businesses (SMEs). KM activities continue to be discussed in Malaysia, where penetration is small. It involves companies with a large level of knowledge which are known to be highly structured entities [18].

Literature Review

Concept of Knowledge Management

The impact of knowledge management on employee satisfaction is the main aim of this research. Studies will recognize and examine in this respect, whether the application in knowledge management can have an impact on the job satisfaction of workers. Knowledge management is the willingness of an organization to acquire, archive, exchange and use knowledge with a common aim to improve their success and achievement. The successful use of information control unlocks members, according to Moffet and Hinds [19]. Knowledge workers are adaptable and agile in order to manage their jobs according to their knowledge, expertise and activities. Based on its bookkeeping interest and its contribution to expertise, companies make progress in the business field and thrive in rivalries [20]. In Syed [21] most specialists strongly recommend the collection and implementation of KM practices, such as the capturing and distribution of the best practices that effectively track consumer relations and provide active input. Malaysian companies have always been behind their distant partners from moving markets, given the uncertainty between the sectors. Rahman [22] has reported that 46% (139 organizations) have formalized KM operations, with 303 educational and policy organizations overviewed. Irritably, only a small amount of 46 per cent (32 organizations) started use and evaluation (18 organizations). At the same time, larger groups were still in the underlying stages of study, review, planning, or setting up spending plans. It is not because companies did not know KM that the sluggish execution is based.

Instead, most Malaysian institutions as they did not know what the potential advantages of KM were, adopted a' sit back and watch' attitude to the introduction of KM projects within their organizations [23]. In comparison, an inability by institutions to understand KM is attributed to the crucial shortage of confirmatory studies on the interaction between KM's operation and work satisfaction. Many scholars with empirical support through the process review approach [24] have stressed how the findings could not be generalized by a broader population even though significant correlations between the KM procedures and KM implementation were established. From now on, the study must cover this void with the exact acceptance that most organizations, in particular information-based companies, must be confident of the relationship between these components. This would promote appropriate KM activities to gain an improved strategic advantage.

KM Practices

KM relates to the distinction and use of the aggregated data in an enterprise to support the company [25]. KM is reportedly a mechanism of information, such as the processing, collection, distribution, transition, and compliance, according to Lee [26]. The independent method of information formation, storage and transmission by Nonaka and Takeuchi has been announced. Demarest and Pruzinsky have also suggested KM mechanisms such as information formation, codification, accumulation of knowledge, knowledge sharing, and preservation of knowledge.

Knowledge Acquisition

According to Zahra and George, the collection of details from extra-organized outlets remains a question of authoritative activity. For a wide range of organizations, global networks and collaboration partnerships become essential information outlets. If the organization works, its clients plan a particularly crucial meeting from which information should be obtained. For starters, the highly-developed information gathering processes are characteristic of customer feedback networks, data mining, business intelligence and collaboration with collaborators or research institutes. The acquisition of knowledge is a complex and continuous process. The ability to develop original thoughts, information, and structures and link them within the company requires knowledge development.

Knowledge Sharing

King has observed that information exchange or diffusion is one of the key components of knowledge management practices. This determines which phase members should send bosses and subordinates their thoughts and productive skills to accomplish their tasks and improve their performance. On the other side, it also speaks about the system used in the different section and entities of the company by workers for the collection or exchanging of data. The approaches used to gather, develop, give, and use information in a viable way for fulfilling different goals are provided by the management of knowledge by Awad. Essentially it is a multidisciplinary technique with defining techniques and processes. The idea that workplace information is communicated with others to maintain successful knowledge management practices is a significant factor to be considered. According to Trivellas, based on previous research, companies are unable to pursue effective information management practices without employee involvement, because employees do not share knowledge. Although several studies have found the role of organizational culture and the system of knowledge sharing, this research was also sponsored by King and needs to find out its effects on employee satisfaction.

Knowledge Creation

Knowledge management refers to the ability of the organization, from technical methods to product and managerial activity, to develop new and useful concepts and strategies about different parts of operational activities. According to Eisenhardt and Martin, he developed the information to motivate the success assisted in chaotic circumstances. Creation of information is created by learning and improving an institution and its knowledge. According to Scharmer, knowledge-building companies cultivate employee capacity and self-experience in order to develop new experiences, grow, and focus on each stage of the company.

Knowledge Retention

Kanto describes the conservation of information as practices related to the management of employee turnover and the resulting lack of experience that is a fundamental advantage of the company. Once employees leave a company for some cause, professional information can be lost. When children's boomers retire, it will become a considerably more pressing task to retain and keep the best employees.

Job Satisfaction

Spector says that job satisfaction is defined as how much people like their jobs (fulfilment) or hate them (unsatisfaction). Employment satisfaction will lead to job performance. The satisfaction of the profession, as defined in Shaikh, indicates that the workers enjoy their job or the positive and happy condition of the worker after assessment. The value of job satisfaction varies according to Fritzsche and Parrish because of the emotions that the individual has in his / her career. Locke also defined job satisfaction as "a component of the obvious relation between what one wants from one's work and what one sees as an advertisement" and the degree to which a worker feels firmly or contrary to his job. The word job satisfaction is similar to the concept of happiness of the worker. The general nature of workplace engagement and functioning is job happiness, as stated by Grant. Three satisfaction indicators are included in the definition: emotional, physical and social. Satisfaction is a primary indicator of human and organizational efficiency. Mismanagement, truancy, presentism, abolishing leave and selling are the result of low satisfaction. The job satisfaction endorsed by Vroom often coincides with the motivation exchange, in which the root of job gratification can be connected with social issues, confidence and self-actualization.

Knowledge Management in Organization

Like the word ' knowledge,' it is also challenging to describe the phrase ' Information Management' (KM). Ultimately, the scale and form of issues that KM is used to consider determine for each company at last the proper definition. In any case, what is most relevant is that each interpretation concentrates on the KM to improve methods of collaboration and appreciation. While KM has earned a terrible name in some quarters because of the fizzled cases of experts making a fast buck, KM is in reality digging in. Spiegler has shown that the KM is simply another thinking, segregated by and removed from data systems, preference of emotionally supportive networks and the management of the data in the past because of the unique nature of the "wisdom" aspect regarding the question of whether KM is "another thought." The importance of information in culture has been viewed.

According to Becerra-Fernandez, the universal belief that learning to live separately, and primarily among employees, is the wealthiest commodity of the enterprise it represents the value of the processes that facilitate production, sharing and use. Given the increasing value of information and modes of instruction, Fahey and Prusak also recognized that organizations are not mainly well managed either. The desire to concentrate on learning and knowledge sources, and to better monitor them, has led to the development of the concept and routine for (KM). Bimpitsos and Petridou, have said that organizations work in an area defined as instability, failure and transition, can contribute to the emergence of various problems. It involves other factors, including increased globalization, accelerated technological changes, the production of professional workplace qualifications and improved performance. The power group, Savaneviciene and Stakeviciute, has announced itself to seek and adventure the properties at their move with a common aim to achieve a target. The criteria to high job satisfaction for instance, task design, ability diversity and complexity has been widely studied according to Glisson and Durick. Nonetheless, among the many job satisfaction indicators to be researched, the challenges of KM have not been listed. Generally speaking, it seems that KM literature in the previous study has scarcely dealt with.

Dominguez defined KM as fundamental elements to the fulfillment of a client. The distinctive difficulties faced by organizations must be understood by Othman, who makes critical use of the KM system. This allows it possible for all organizations to work with these properties. The use of a variety of activities to help organizations and monitor their success while they focus on their state of mind and their procedures as Ortega-Parra and Sastre-Castillo say. With the help of Yew, companies are looking to develop the workplace conference and to find the perfect way to maintain the morale of their workers. The organization's operations, as suggested by Tiwari and Saxena can be improved through the operation of the KM available to the organization in areas such as staff service, expertise and adaptability.

More precisely, few KM activities can impact the roles of workers, which can include registration and choosing, planning and development, assessment of results, collaboration and compensation and incentives. Nevertheless, as reported by Fong, staff chooses to leave the organization, the awareness would eventually be lost. That's why companies are trying to improve (KM) protecting, appropriating, recognizing and bureaucratic knowledge processes. The study is based on the interaction between KM and employee satisfaction, organizational accountability on the one side, and the company on the other. The essential parts analyze the logical context, explore method, research concept and hypotheses to achieve this.

Justification for using quantitative data

Quantitative and qualitative methods are two different techniques used for data collection. The quantitative method is based on distributing questionnaires over specified number of respondents, while the qualitative depends on conducting interview questions to study the point of view regarding a specific topic. Both methodologies will be implemented in the research.

Research Design

The research design (Figure 1) is made up of six elements, and they are listed as follows:

- Questions of the Research: The primary motivation behind the research is to address the impact of knowledge management on organizational commitment in the Organizations.
- Methods Used: Is a tool used for collecting data, both methods will be practiced in the research. Data Collected: Data will be gathered through distributing surveys.

- Variables: The dependent and independent variables are two different types and both will be studied in the research.
- Data Analysis: Data will be analyzed using the SPSS statistical tool for hypotheses validation
- Theoretical Framework: addressed through previous studies and researchers and it is mentioned in the review of the literature.

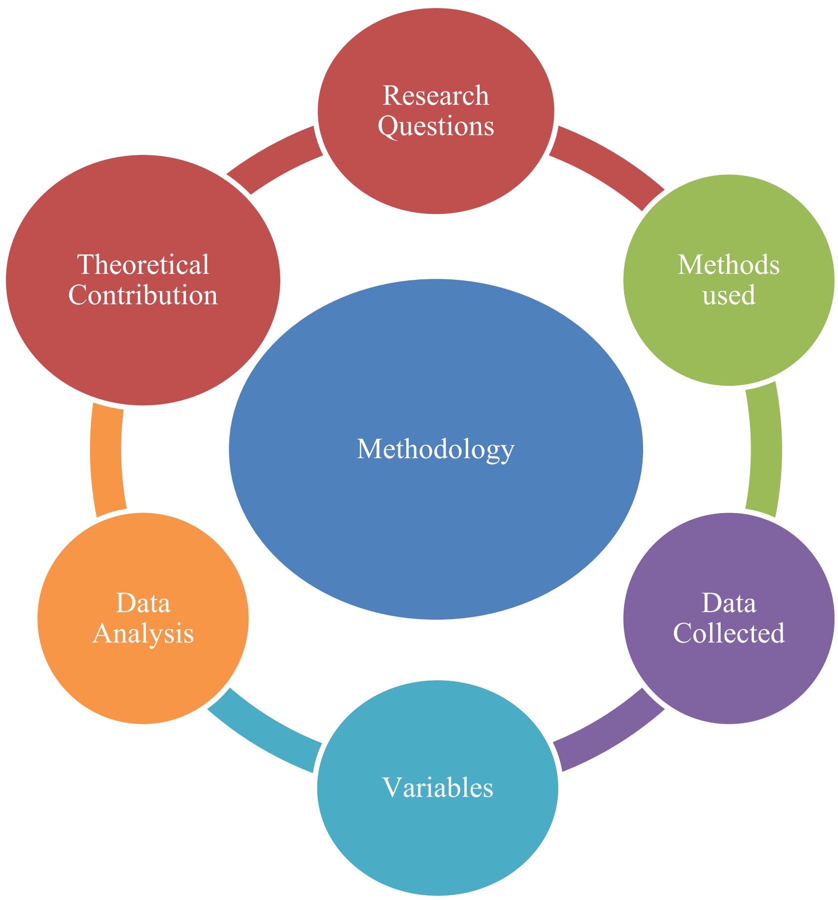

Figure 1. Research Design

Instrumentation

The research will practice both methodologies for data collection. The quantitative methodology will be distributed among 100 respondents in different positions. The collected data will be analyzed using the SPSS statistical tool, and the outcomes will be viewed in the form of statistical Figure 1 and inferential statistics for hypotheses validation.

Regression

Table 1. regression analysis of relationship between Knowledge management and employees commitment

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.546[a]	.299	.287	.882

a. Predictors: (Constant), Knowledge management is enhanced through E-Learning Systems

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.467	.266		5.524	.000
	Knowledge management is enhanced through E-Learning Systems	.570	.114	.546	5.011	.000

a. Dependent Variable: E-Learning tools enhances team cooperation

The above regression analysis showed in Table 1, a standard error of 0.00 which is much lower than 0.05 which means the null hypothesis which states that "There is an insignificant relationship between Knowledge management and employees commitment", and the alternative hypothesis which states that "There is a significant relationship between Knowledge management and employees commitment." is accepted. As for the R-Square, it showed a sign of 29.9%, which is above 25% this means that there is a strong relationship among the research variables.

Table 2. regression analysis of relationship between E-Learning and employee's commitment

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.610[a]	.373	.362	.834

a. Predictors: (Constant), E-Learning helps employees achieve satisfaction in their workplace

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.272	.259		4.904	.000
	E-Learning helps employees achieve satisfaction in their workplace	.601	.102	.610	5.920	.000

a. Dependent Variable: E-Learning tools enhances team cooperation

The above regression analysis showed in table 2, a standard error of 0.00 which is much lower than 0.05 which means the null hypothesis which states that “There is an insignificant relationship between E-Learning and employees’ commitment”, and the alternative hypothesis which states that “There is a significant relationship between E-Learning and employees commitment” is accepted. As for the R-Square, it showed a sign of 37.3%, which is above 25% this means that there is a strong correlation among the research variables.

Table 3. regression analysis of correlation among knowledge enhancement and employee’s commitment

Model Summary

Model	R	R Square	Adjusted R Square	Std. error of the Estimate
1	.488[a]	.238	.225	.919

a. Predictors: (Constant), The knowledge I’ve gained through the Bank e-learning system enables me to do my job better

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.629	.270		6.036	.000
	The knowledge I’ve gained through the Bank e-learning system enables me to do my job better	.405	.094	.488	4.297	.000

Dependent Variable: E-Learning tools enhances team cooperation

The above regression analysis showed in table 3, a standard error of 0.00 which is much lower than 0.05 which means the hypothesis which reveals that “There is an insignificant correlation among knowledge enhancement and employees commitment” is not accepted, and the alternative hypothesis which states that “There is a significant correlation among knowledge enhancement and employees commitment” is accepted. As for the R-Square, it showed a sign of 23.8%, which is near 25% this means that there is a strong correlation among the research variables.

Pearson Correlations

Table 4. Implemented to test of Pearson correlations

Correlations

		E-Learning tools enhance team cooperation	Motivation is enhanced through E-learning tools	E-Learning systems enhance work engagement	E-Learning helps employees achieve satisfaction in their workplace	Employees use E-Learning tools to develop their skills
E-Learning tools enhances team corporation	Pearson Correlation	1	.361**	.500**	.610**	.589**
	Sig. (2-tailed)		.004	.000	.000	.000
	N	61	61	61	61	61
Motivation is enhanced through E-learning tools	Pearson Correlation	.361**	1	.588**	.590**	.374**
	Sig. (2-tailed)	.004		.000	.000	.003
	N	61	61	61	61	61
E-Learning systems enhances work engagement	Pearson Correlation	.500**	.588**	1	.670**	.482**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	61	61	61	61	61
E-Learning helps employees achieve satisfaction in their workplace	Pearson Correlation	.610**	.590**	.670**	1	.586**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	61	61	61	61	61
Employees use E-Learning tools to develop their skills	Pearson Correlation	.589**	.374**	.482**	.586**	1
	Sig. (2-tailed)	.000	.003	.000	.000	
	N	61	61	61	61	61

Pearson Test had been implemented to test whether there is a positive or negative relationship between the research variables as shown in table 4, and the results are as follows:

- Positive correlation among team corporation and motivation (0.361)
- Positive correlation among team corporation and work engagement (0.50)
- Positive correlation among team corporation and job satisfaction (0.610)
- Positive correlation among team corporation and skills development (0.589)
- Positive correlation among motivation and work engagement (0.588)
- Positive correlation among motivation and job satisfaction (0.590)
- Positive correlation among motivation and skills development (0.374)
- Positive correlation among engagement and job satisfaction (0.670)
- Positive correlation among engagement and skills development (0.482)
- Positive correlation among satisfaction and skills development (0.586)

Validity and Reliability`

Table 5: The reliability Statistics of data collected

Reliability Statistics

Cronbach's Alpha	N of Items
.894	13

The validity of the data collected had been tested using the validity and reliability analysis as shown in table 5. The Cronbach Alpha should indicate a sign between 0.7 and 1 to ensure that the collected data are valid and ready for statistical analysis. Referring to the Cronbach Alpha mentioned in the above table, it showed a sign of 0.894 which is between 0.7 and 1, this means that the data collected is valid and ready for statistical analysis.

Theoretical Framework and Hypothesis

The paper describes the conceptual framework used by the evolving systems and by incorporating previous studies and literature. Wise information, knowledge sharing, development of knowledge and knowledge preservation are activities adapted as an independent variable (IV). Thus, employee satisfaction as a predictor is the dependent variable (DV). In this portion, alongside the variable overview and the association with another analysis, you will find the definition of each variable. This research would investigate and suggest hypotheses for the interaction between the independent variables and the dependent variable.

Knowledge Acquisition and Job Satisfaction

The acquisition of knowledge (creation) requires an opportunity to formulate, and integrate into the organization, original thoughts, knowledge and arrangements. The KM scale developed by Darroch has been used to assess KM activities in the organizations surveyed based on Jayasingam, researching them. The metric requires the development of information. According to Jayasingam this research concentrates on the success of KM projects viewed by individuals with the consequences of KM projects instead of taking objective measures as the KM outcome were difficult to measure. Bose notes that KM projects are constant, and continuing programs and success assessments of KM projects should be seen as factors that contribute to or strengthen an organization rather than as an end alone. The degree of change is therefore used instead of the level of achievement as success calculation. The analyst then suggests that the correlations are

between the acquisition of knowledge and employee satisfaction.
Hypothesis 1: The relationship between knowledge acquisition and job satisfaction

Knowledge Sharing and Job Satisfaction

The exchange of information between individuals, communities, organizations and institutions is a function of knowledge sharing. The association between job satisfaction and the sharing of knowledge is highly correlated to the value of 0.934 based on Saeed results. Saeed proposed that information exchange would be more relevant than worker efficiency based on the results. Improved incentives for workers to share knowledge and other personnel to develop new concepts, to discuss facts, and to make an essential commitment to achieving the goals of the organization. This is also evident from the findings of this study, which the workers seek to share knowledge with others to enhance their job performance. In line with Trivellas, this finding also explored the positive connection between sharing knowledge and interaction with the workplace. The study concludes that the correlation between the exchange of information and employee satisfaction is fulfilled.
Hypothesis 2: There is a relationship between knowledge sharing and job satisfaction

Knowledge Creation and Job Satisfaction

Knowledge development applies in turn to the capability of the company, from publications and technologies to management practices, to developing a new and useful concept and approach in different areas of the corporate operations. According to the research by Prunzinsky, the development of information does not affect happiness at work. This could be attributed to the research background. It is likely that neither acquisition of information (particularly from sources or collaborators outside the organization) nor creation of new knowledge may be essential for the nature of the work carried out in that municipal institution. Such practices are not supported by the organization's sponsorship or recompense. We, therefore, have no effect on productivity at work. The researcher then concludes that the connection between generating information and pleasing the workforce. Based on the above study, the researcher therefore proposed for the following hypothesis
Hypothesis 3: There is a significant relationship between Knowledge Creation and Job Satisfaction

The Relationship between Knowledge Retention and Job Satisfaction

Information preservation relates to a critical strategic tool, the activities related to staff change reduction and associated professional information depletion. The critical KM method of this organization was information conservation, which implies that the consistency and maintenance of knowledge were crucial for the functioning of the company. This is to be anticipated as, when developing path-dependent approaches, an entity wants a comprehensive and meaningful view of its past. The Team, therefore, needs to understand the external forces and the organization's structural and regulatory climate. The remaining knowledge retention and job satisfaction are based on a study by Kianto. The findings specifically show that information exchange is the primary KM mechanism in the company and encourages job satisfaction for most classes of workers. The writer then suggests that the exploration of generating information and rewarding workers. Based on the above study, the researcher therefore proposed for the following hypothesis

Hypothesis 4: There is significant relationship between Knowledge Retention and Job Satisfaction

Conclusions

Finally, this design paper provides a broad understanding of knowledge management and happiness in work. In consideration of research papers and ideas published by academics and experts in this area, the literature from past studies is reviewed. This research also explores the end goal of clarifying and interpreting the effect of information management on the productivity of workers through numerous performance reports in the past. A systematic analysis examination is also carried out to research the elements to be included in the study addressing the aspects of information management and job satisfaction. The happiness of an employee can be shown with the calculation of a person's job satisfaction that KM practices. A philosophical structure is proposed as the basis for conducting the study, using the principle of embracing and adapting. More research should be done to improve the understanding of concepts and the impact of KM on the happiness of workers.

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Hardware Implementation of PV fed boost converter with quasi resonant voltage doubler and snubber circuit

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Abstract— In this article, hardware implementation of PV fed boost converter with quasi resonant voltage double and snubber circuit is presented. This method clarifies the improvement of a boost half-bridge (BHB) DC-DC converter with high power transformation efficiency and a wide voltage range for photovoltaic smaller scale inverter. The improvement is accomplished by presenting an isolation Transformer, interfacing the BHB DC-DC converter on the essential side of the transformer and including a voltage doubler with a snubber capacitor on the auxiliary side. Quasi Resonance (QR) strategies are utilized to accomplish zero-voltage exchanging (ZVS) turn-on for the switches, just as ZVS turn-on for the diodes. Furthermore, the new improved converter has no DC-charging current for the transformer because of the DC blocking capacitor, and it duplicates the voltage increase through the voltage doubler and snubber capacitor to diminish spikes Further, an extensive hardware validation show the effectiveness of the system.

Keywords— Photo voltaic Systems, Micro Inverter, DC-DC Converter, Quasi Resonance, Power Conversion.

I. INTRODUCTION

Lately numerous nations satisfy the power need, so the age of renewable power source is expanded, for example, photovoltaic, wind, fuel and so on. The sun gives all that anyone could need vitality to meet the entire world's vitality needs, and not at all like petroleum products, it won't run out at any point in the near future [1-2]. As a sustainable power source, the main impediment of sun oriented force is our capacity to transform it into power in a proficient and savvy way. No ozone depleting substance emanations are discharged into the environment when you utilize sun powered boards to make power. Also, on the grounds that the sun gives more vitality than we'll ever require, power from sun based force is a significant vitality source in the transition to clean vitality creation. After sun based boards have been introduced, operational expenses are very low contrasted with different types of intensity age. Fuel isn't required, and this implies sun based force can make huge sums of power without the vulnerability and cost of verifying a fuel supply. The progression up DC-DC converter for a smaller scale inverter must have a high voltage gain G (V_O/V_{IN}) of a few tens or more [3-4]. In this manner, if a traditional DC-DC help converter is utilized for a small scale inverter, the switch must have an incredibly high duty ratio. Be that as it may, this outcomes in huge current flows, losses due to conduction, and losses due to switching losses of the electric influence segments in the converter. Non-isolated DC-DC converters have been concentrated to defeat these issues in Step-up DC-DC Converters above [5-7].

To accomplish high voltage gain without an amazingly high duty ratio of the principle switch, non-isolated converters utilize detached and dynamic parts rather than a transformer. In any case, non-isolated DC-DC Converters have complex structure, electro-attractive obstruction, grid current contortion, and extra misfortunes because of the spillage current produced by the galvanic association between the PV module and grid [8-9]. The traditional flyback converter has the littlest circuit parts and circuit size. In any case, it has burdens of the low voltage increase, high voltage worry of the rectifier diode, and high voltage spike issue of switch[10-11]. To take care of these issues, the dynamic clamp flyback converter with a voltage doubler was presented.

The proposed converter utilizes the quasi-resonance among C_1 and L_{lk}. Contrasted with the past converter it can decrease the turn off current of S_1 and obligation loss of the circuit in view of the quasi-resonance among C_1 and L_{lk}. Along these lines, this converter of has the littler turn off misfortunes and more extensive voltage at the input side run than that of past converter

PROPOSED SYSTEM

In proposed system shown in Fig 1 the PV panel input voltge is fed to the DC load with the help of half bridge boost converter which converts the DC voltage with AC voltage with some boost ratio and then it converted AC voltage is stepped up using turns ratio of transformer and then voltage doubler circuit converts the doubles the AC voltage to DC voltage which drives the load.

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Smart Industry Monitoring and Controlling System Using IoT

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Abstract. Air pollution in an ecosystem has proliferated industrial automation. This dissertation concentrates more on industrial automation and has design an embedded device with sensors to monitor and control the toxic gases in industries. This entire prototype is an excellent result for observing the toxic gases in industry and generates information by using data acquisition and transmission of data.“Internet of Things (IoT)” is a important technology behind this and it provide platform to bring together all the devices in the world to the internet. In this dissertation, the parameters monitored are temperature, humidity and gas leakages in industries. The sensor senses the parameters and uploads these data to the cloud with the help of NodeMCU. If observed gas level is above the threshold which is the safety limit of operation, the first alert is intimated from the Google cloud and the controlling action carried out (ie) automatically close gas leakage valves and then industry will take immediate step to control pollution. Or else, the second alert message is sent through Electronic mail (e-mail) to restore the safe limit, as government play role to power outage in the industries. Cloud is used to store the sensed data, which is then transmitted and processed.

Keywords. Air pollution, Toxic gases, ECO-system, ESP8266 and IoT.

1. Introduction

In the recent years wireless technology and IoT grasped the most industrial area especially automation and control has increasing for need of upholding various sectors. Healthcare has prime importance in our day to day life. This paper reviewed about new industrialization with ESP8266 and arduino UNO. Indoor Air Quality (IAQ) is highly worsens industrial environments, which then spreads from indoor to outdoor, creating a large scale effect around the industrial areas. Long term and short term effects caused by Air pollution causes the people to concern about the air they breathe. The effect of air pollution from industry is monitored scarcely. Our aim is to monitor the air pollution from the heavy industry which leads to undesirable effects on the health of human beings and also affects the environment. Pollution level in comparison to the ambient air quality standards can be done by using monitoring. To protect the people against extreme air pollution. Robust monitoring systems are necessary to alert people and initiate actions.

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2. Review of Related Literature

Kavitha.B.C et al. (2019), insists on using intelligent sensors for pollution monitoring. Collected data from the sensors are sent to the Google cloud makes it possible to monitor the air pollution from anywhere in the world. In case of threating levels of air pollution, alerting is used. This is used in industry and the pollution by vehicular emissions. Rajalakshmi.R et al. (2019), Observes the toxic gases present in the air to ensure the safety of the people in that environment and make it available at any place in the world for monitoring. The composition of chemicals in air like carbon monoxide, LPG, methane and flammable gases is monitored using sensors and this data is sent to the cloud server, which is then represented pictorially for better understanding of the statistics. Rupali et al. (2018), cares for home and industrial safety using fire and gas detection systems. This system detects the leakage of gas and fire using sensing circuit, which is then controlled by microcontroller which in turns triggers the alarm system to alert the leakage of gas and fire. Using GSM modems, SMS are being sent to notify the user. In addition, it is designed with mechanism to sprinkle the water using water sprinkler when there is a fire or gas leakage. MQ-6 and MQ-9 used as gas sensors to detect the gas leakage. IR flame sensor is used for fire detection, which detects the fire and notifies the user using SMS. Manish Verma et al. (2018), uses microcontroller based system to investigate about the toxic gas detection and alerting system. LCD display is used where the levels of hazardous gases like LPG and propane was displayed each second. Authorized person is notified with email and also using alarm generation mechanism. This automated detection and alerting mechanism helps to resolve the problem as soon as possible. Angelica Nieto Lee et al. (2018), this paper focuses on integrating all the contextual data, to provide accurate and relevant information as per the need. System information that already exists but has not been integrated into the monitoring system like 3D models and manuals. It is context aware industrial monitoring systems, which provide information based on system state, environmental conditions and functionalities of the devices in that environment. Ishwarya et al. (2018), insisted on automation of many small tasks around us using Internet of Things (IoT) in order to improve the quality of living. IoT is used for enhancing existing safety standards, using automation process. Gas leakages in open or closed areas can prove to be dangerous and fatal. Traditional gas leakage systems can able to detect the leakage but cannot able to alert the user. Alerting System can be established to alert the authorized person and to perform the data analytics from the obtained readings.

3. Proposed System

The figure 1 below shows the block diagram and prototype of the proposed system. The components used to design the hardware are Arduino UNO, Semiconductor sensor (MQ6 & MQ7), ESP8266, Relay , Power supply. MCP3008 is an analog to digital convertor. Analog values from the sensors are given to MCP3008, which is an 8 channel ADC, that converts the analog data to digital data which is then sent to NodeMCU. The parameters are monitored using DHT11, MQ-6, and MQ-7 sensors. The sensor senses their parameters regarding the temperature, humidity and gas level and uploads these data to the cloud with the help of WiFi device (NodeMCU). If the level of the gas reaches above the normal level, the first alert is intimated from the

Google cloud as it is automatically closes gas leakage valve and then industry will take immediate step to control pollution. Or else, the second alert message is sent through Short Message Service (SMS) to restore the safe limit intended so and as government play role power outage in the industries.

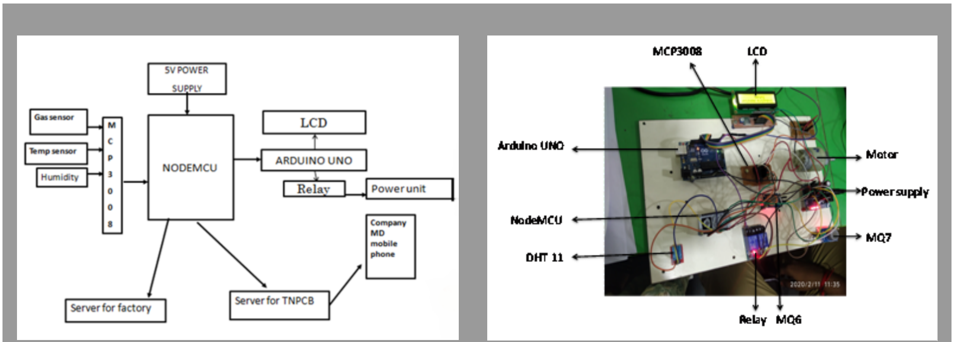

Figure 1.a Figure 1.b

Figure 1. Block diagram and prototype of the proposed system

4. Result and Discussion

We are going to test our prototype for different cases are discussed below. For our analysis Gas-1 represents carbon monoxide (CO), Gas-2 represents Isobutane, Propane, Liquefied Natural Gas (LNG) and Methane. Temp represents temperature. Humi represents humidity. Status represents either normal or emergency based on the industrial gas leakage level.

Analysis for Gas-1

In the figure 2.a,the permissible level of Gas-1 is below 300. In this case, Gas-1 does not reaches permissible level, so it is not harmful to the environment. Hence the status is normal.In the figure 2.b, the permissible level of Gas-1 is above 300. In this case, Gas-1 reaches above permissible level so it is harmful to the environment. Hence the status is emergency.

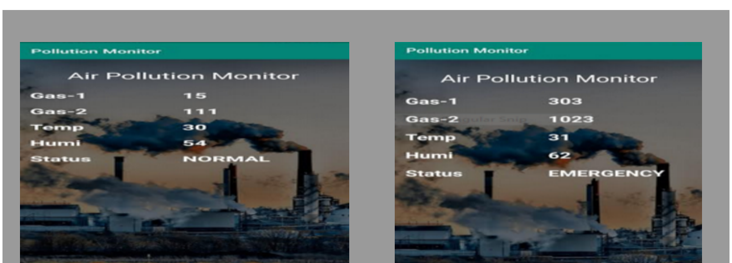

Figure 2.a Figure 2.b

Figure 2. Output of Gas-1

Analysis for Gas-2

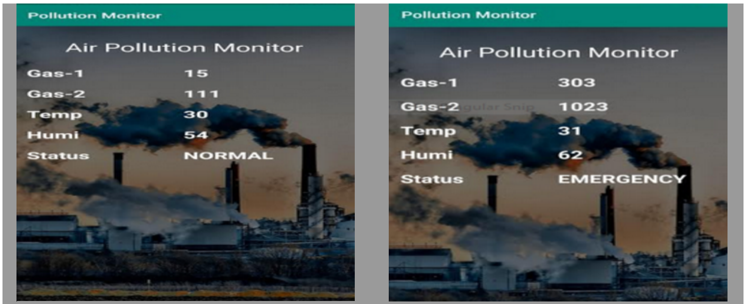

Figure 3.a Figure 3.b

Figure 3. Output Gas-2

In the figure 3.a, the permissible level of Gas-2 is below 300. In this case, Gas-2 does not reaches above permissible level so it is not harmful to the environment. Hence the status is normal. In the figure 3.b, the permissible level of Gas-2 is above 300. In this case, Gas-2 reaches above permissible level so it is harmful to the environment. Hence the status is emergency.

5. Conclusion

In this paper smart Industry Monitoring system based on IoT is proposed which can effectively monitor and controls with alert. A prototype based on Arduino UNO was developed which could sense the concentration of gases. The real time data information obtained from the different sensors has been uploaded to Google Cloud which displayed in the LCD. In addition to this other parameters like temperature, humidity was measured. Provision was also made to vigilant the workers in case of any emergency. The system provides consistently and accurate analysis to prevent any case of accidents. This system makes use of Arduino UNO providing cheap solutions for safety. Slight modification of the model enables the user to adapt it to any environment. Predictive maintenance is an upcoming industrial need, for which the proposed model can be improvised. In case of gas leakage the concentration of gas varies from point to point which has to be analyzed. Moreover, the gases diffusing out during leakage may also combine among themselves producing other by products which have to be dealt in detail.

6. Future Scope

This prototype helps the industrial site from gas leakage deduction and faster resolution of problems afforded by a higher level of expertise focused on control system. This methodology could be applied to monitor distribution network of natural gas as well as industrial, commercial, residential gas pipelines in order to provide a safe operation and to avoid severe human health injuries caused by gas leakages. Proposed solution can act as a automatic vehicle health feed for manufacturer to improve their quality by providing regular vehicle services.

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