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Original Article

Correlation of Audio-Visual Reaction Time with Body Mass Index & Skin Fold Thickness Between Runners and Healthy Controls

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Abstract

Audio-visual reaction time is essential for activities like driving and very important in sports persons. Reaction time of 31 National level runners was compared with 31 controls. Runners were subdivided into two groups, group A (>2 yrs & < 3 yrs of training) and group B (>3 yrs & < 10 yrs of training). Correlation between Body Mass Index & Skin Fold Thickness with reaction time was also analyzed. Reaction time was significantly less in runners ($p<0.05$) when compared to controls and also in group B. Correlation analysis has shown negative correlation of BMI with reaction time with statistically significant value for green color in runners. Skin Fold Thickness also showed a negative correlation with reaction time but was not statistically significant. Improvement in reaction time by regular practice will ultimately improve sports person's performance.

Introduction

Sports are organized at competitive levels since ancient times. In India the scientific community has recently started contributing towards upliftment of an athlete. But still looking at the vast sporting population, this contribution appears to be meager.

Reaction time is defined as interval of time between presentation of stimulus and appearance of appropriate voluntary response in a subject (1). The reaction time is often overlooked and usually underestimated element in the selection of athletes for different sports. In sports and games, in which movements of a participant are conditioned by signals, by movements of opponents, or by motion of the ball, reaction time is of great importance. A sprinter who can start faster than other contestants; a baseball catcher who can react faster to the change in the direction of the motion of the ball; a ping pong player who is always in the right place at the right time- all have a definite advantage over slower reacting men (2).

Since performance of an athlete is directly linked with duration of reaction time, athletes and coaches are starting to realize importance of reaction time in sports performance. Because of this realization, research is necessary to scientifically show athletes

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and coaches the effect of reaction time on their sports performance so that it will be useful to screen a large population for physical fitness.

The study of relation of the reaction time to motor skill performance in sport is not new, but in the past not much attention was given to elite athletes (2). Reaction time measurement is an indirect index of processing capability of central nervous system and simple means of determining sensory motor association and performance of an individual (3).

Anthropometry is the study of the measurement of the human body in terms of the dimensions of bone, muscle, and adipose (fat) tissue. It is a scientific measurement of human body and it includes measurement of body size, mass and proportion. Includes height, weight, circumferences, skinfold fat thickness and body mass which are used to predict body density and body fat. It is well accepted that excess body fat is detrimental to health. Excess fat has been linked to an increased risk of developing hypertension, type II diabetes mellitus, coronary heart disease, osteoarthritis (4). Reduction of body fat has been associated with performance improvement in specific sports. So, body composition analysis is frequently included in physical fitness assessment. In the era of competitions winning is what being honored; for which the performance counts. Performance depends on many factors but reaction time and its correlation with BMI and SFT reaction time is one among that which is not given that much importance. BMI and SFT are very important factors which need to be concentrated more when we look for the performance in a sports event.

There is a controversy in studies regarding negative and positive correlation of BMI with the reaction time (4-8). Various neurophysiological studies have shown that greater BMI is associated with reduced cognitive performance especially in areas of attention, execution and memory (9). Auditory and visual reaction time is considered as an ideal tool for measuring sensory motor association (10, 11). Negligible studies are there showing relation between SFT and reaction time. Hence, to extend our knowledge about the association between BMI, SFT and reaction time, this study has been conducted. Many studies have been conducted to assess reaction time in soccer players, badminton players, basketball players, yoga practitioners but reaction time in runners appears less. Hence in view of the above, this study is undertaken which will scientifically contribute to the field of reaction time and will be the foundation for future studies in this regard.

Methods

The present study was conducted in the Department of Physiology, Jawaharlal Nehru Medical College, Belgaum, between January 2010 and December 2010.

Study Design:

Cross-sectional study.

Method of Data collection

Source of Data: In the present study the data was collected from the runners (National & State level players) practicing regularly at district stadium, Belgaum and students of M.B.B.S, AHSC, BDS, and BPT batch enrolled in KLE University.

Sample size: Based on universal sample size all the runners aged 16-25 yrs of Belgaum city who are eligible were enrolled at the time of data collection and available number of players who fit into the inclusion criteria were 31. For comparison, age (16-25 yrs) and sex matched MBBS, AHSC, BDS, BPT students admitted in KLE University, Belgaum were enrolled as controls. Selection was done using random number table. Data collection was done from the month of July to December 2010.

Inclusion Criteria:

1. All the runners practicing for a minimum period of 2 years and who were in the age group of 16-25 yrs.

2. All the students of age and sex matched participants coming from same region who have not undergone any sort of athletic training or carrying out regular exercise will be selected

randomly in comparative group.

Exclusion Criteria:

1. Subjects with respiratory, neuromuscular, cardiac, endocrine disorders in study subjects & comparative group.

2. Students from comparative group who were doing regular physical exercise, meditation and undergoing physical training.

Procedure:

List of runners was obtained from the stadium and the coach Information about their practice schedule, number of players, and their availability was taken from the coaches. Permission was obtained from the Assistant Director, District stadium, Belgaum to carry out the intended study on the players. The study was approved by the Ethical and Research Committee of the institution.

After finding the suitability as per selection criteria, the players were selected for the study and briefed about the nature of the study and written informed consent was obtained from them.

Descriptive data of the participant's age, medical history, training schedule regarding number of years of practice, number of days in a week, number of hours per day, etc were obtained by interviewing the participants.

The sports participants were subdivided into two groups depending on number of years of training. Group A consisted of runners with >2 yrs and ≤ 3 years of practice and Group B consisted of the senior players with > 3 years and < 10 yrs of training (12, 13). All the players participated in consistent training. On an average practices were held for four to five hours per day, six times per week. Throughout the year, apart from running practices, all participants were involved in additional sessions of strength training and conditioning, speed, and stretching both pre-season and during the competitive season. Both groups had been exposed to similar training regimens.

Anthropometry: (14, 15)

1. BMI : Height (cm) was measured by Commercial stadiometer to the nearest 0.5 cm. The participant was made to stand erect with bare foot on the floor board of the stadiometer with his or her back to the vertical backboard of the stadiometer.

   Weight (kg) was recorded by Digital scale with an accuracy of ±100 gm, participant was asked to come in light clothes and bare foot.

   BMI was calculated by from height and weight using Quetelet's equation

   BMI = body weight in kg/(height in meters)^2

2. Skin fold thickness (mm) was measured by Harpenden skinfold calipers (Baty International, West Sussex, UK). Seven sites were identified, readings were taken on the right side of the body, 1 cm away from thumb and finger perpendicular to skin fold halfway between crest and base of fold. Pinch was maintained throughout the recording. Waited for 2 sec before recording. Mean of two measurements were considered. Seven sites measured were: **Triceps**: Vertical fold, on the posterior midline of the upper arm, half way between acromion and olecranon process; **Subscapular**: Diagonal fold, 1 to 2 cm below the inferior angle of scapula; **Midaxillary**: Vertical fold, on the midaxillary line at the level of xiphoid process of sternum; **Abdomen**: Vertical fold, 2 cm to the right side of the umbilicus; **Suprailiac**: Diagonal fold, in line with the natural angle of the iliac crest taken in the anterior axillary line immediately superior to the iliac crest. The skinfold should slope downward and forward at a 45 degree angle extending toward the pubic symphysis; **Chest**: Diagonal fold midway between the anterior fold of axilla and Nipple; **Thigh**: Vertical fold, on the anterior midline of the thigh, midway between the proximal border of patella and the inguinal crease. The participant stood with his weight shifted back on the left leg with the right leg forward, knee slightly flexed and foot flat on the floor.

Sum of all seven sites was taken to assess Skin Fold Thickness.

Reaction time:

The apparatus used in this study was the portable research reaction timer with two response choices latest manufactured in March 2010 and was purchased from Anand agencies, Pune, which can measure Auditory Reaction Time (ART) and Visual Reaction Time (VRT).

Specifications of reaction timer:

1. Inbuilt chronoscope – 4 digit chronoscope with least count of 1/1000 seconds.

2. It works on – 230 volts AC (11).

After familiarizing the subject with the instrument and after repeated practice, Auditory Reaction Time (in msec) for Beep tone and Click was determined for both right and left hand. The procedure was repeated for three times and three readings which appeared on the display were noted. The least reading of the three was taken as subject's best auditory reaction time and was recorded in the subject's record profile. The inter stimulus interval was randomly adjusted between 5-10 seconds. The same procedure was followed for determination of visual reaction time (in msec) for Red and Green stimuli using both hands (16).

Statistical analysis was done using SPSS 16.0. Mean and standard deviation for reaction time was calculated and difference between mean of the two groups was tested using unpaired 't' test, where significance of the P value was < 0.05. Pearson Correlation analysis was done for reaction time with BMI and SFT.

Results

Reaction times of 31 runners are compared with 31 controls. Runners were subdivided into two groups, group A (>2 yrs & < 3 yrs of training) and group B (>3 yrs & < 10 yrs of training).

Table I, II & graph 1, 2 show the comparison of reaction time between runners, controls and between two groups of runners.

Table III shows the correlation between the BMI & SFT with reaction time (click, tone, white, red, yellow & green) in runners and controls. There was a negative correlation for all the reaction time parameters with BMI for runners but it was not statistically significant except for green color, which showed that green color auditory reaction time has a statistically significant correlation in runners. There was a negative correlation for all the reaction time parameters with SFT for runners but it was not statistically significant.

TABLE I : Comparison of Reaction time between runners & controls.

		Runners	*Controls*	*P-values P*
Auditory	Click	180.5±34.02	264.9±47.58	0.000*
	Tone	177±28.54	277.9±55.89	0.000*
Visual	White	190.1±27.80	281.7±54.19	0.000*
	Red	191.1±34.83	272±53.26	0.000*
	Yellow	185.9±28.10	266.7±48.03	0.000*
	Green	181.5±32.13	269.3±46.80	0.000*

(*) p value significance <0.05.

TABLE II : Comparison of Reaction Time (Auditory & Visual) of two groups..

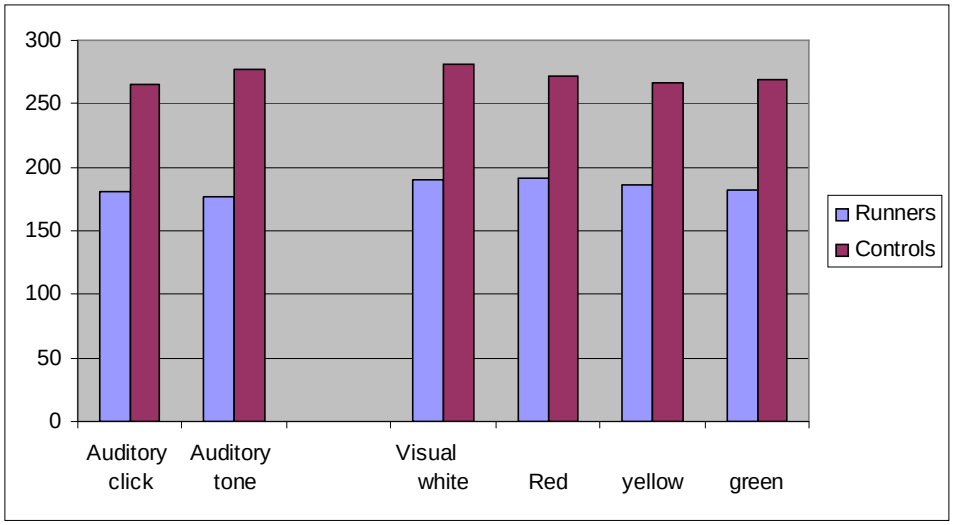
		Group A	*Group B*	*P-values P*
Auditory	Click	204.1±30.85	165.6±27.23	0.001*
	Tone	191.2±30.73	168.1±23.71	0.025*
Visual	White	205.2±32.59	180.6±19.79	0.014*
	Red	214.7±37.17	176.2±23.95	0.001*
	Yellow	202.9±22.51	175.2±26.32	0.005*
	Green	198.6±19.32	170.7±34.27	0.016*

(*) p value significance <0.05.

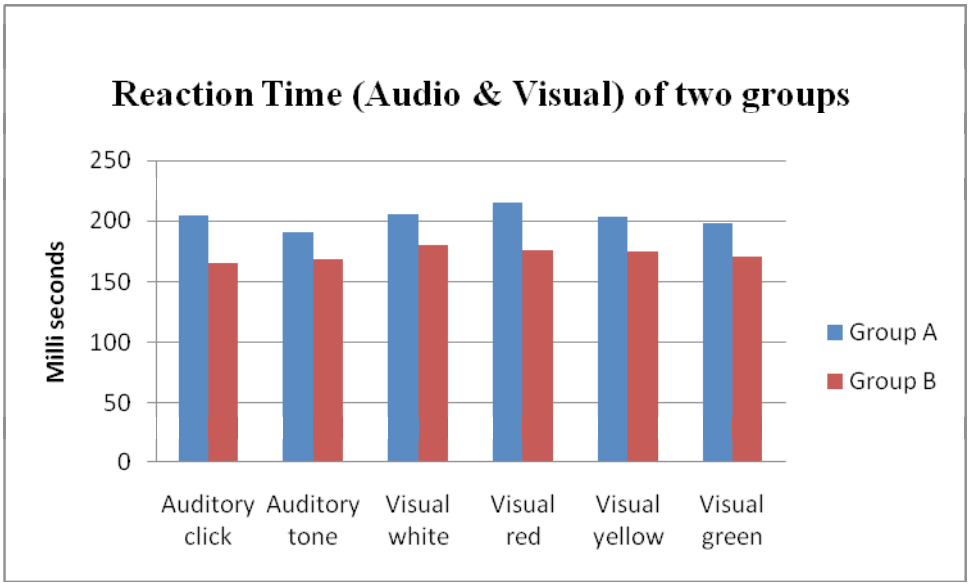
TABLE III : Correlation between reaction time of runners and controls with BMI & SFT.

		Click	*Tone*	*White*	*Red*	*Yellow*	*Green*
BMI	Runners	-0.013	-0.267	-0.189	-0.140	-0.247	-0.378*
	Controls	0.329	0.165	0.248	0.163	0.319	0.201
SFT	Runners	0.114	-0.057	-0.307	-0.235	-0.232	-0.277
	Controls	0.105	-0.011	0.031	-0.40	0.073	-0.17

(*) correlation is significant at the 0.05 level.



Graph No. 1 : Comparison of Reaction time between runners & controls.

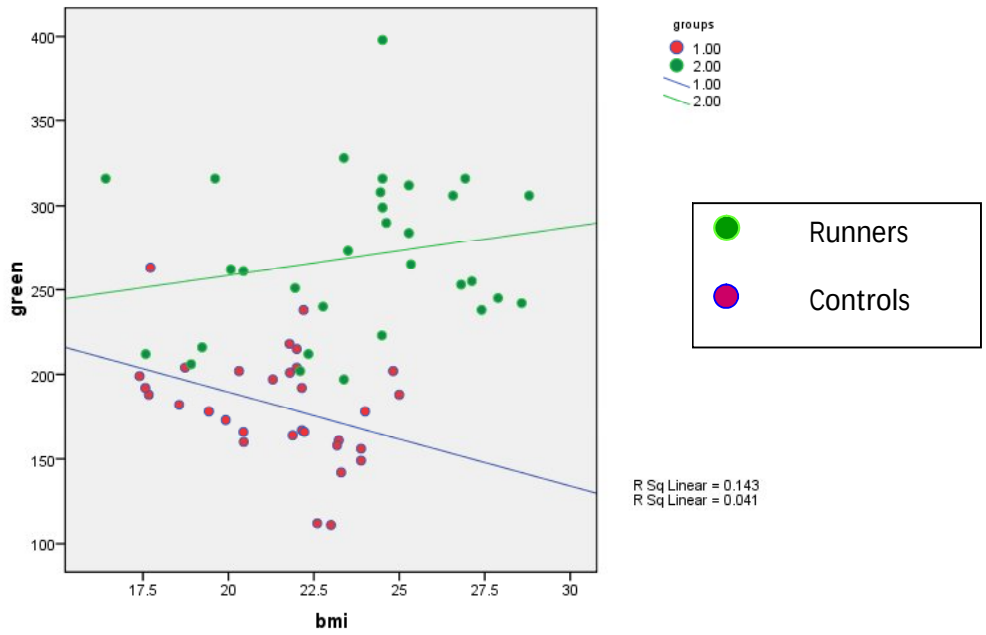


Graph No. 2 :
- Auditory (click, tone) and visual (white, red, yellow and green) reaction time showed lesser values in runners than controls which was statistically significant ($p<0.05$).
- Auditory (click, tone) and visual (white, red, yellow and green) reaction time showed lesser values in group B than group A which was statistically significant ($p<0.05$).

Graph 3 shows that linearly there is an increase in the visual reaction time (green) as the BMI increases in runners.

Discussion

Audio-visual reaction time is the time taken by an individual to react to an auditory or visual stimulus respectively. It can be of crucial value in activities like driving and is an important quality of a sports persons (17). In the present study Auditory and visual reaction times were significantly less in runners than in controls. These changes are due to the effect of training in the runners. Also among senior players there was a significantly lower reaction time. Reaction time is a crucial factor in deciding success in many sports. The quickness of response depends on the integrity of cell communication, sensory perception, central processing and motor response. The significant decrease in reaction time (auditory and



Graph No. 3 : Correlation between visual reaction time (green) as the BMI increases in runners.

visual) in athletes can be explained on the following basis: improved concentration and alertness, arousal induced as a result of exercise which supports alertness to external environmental stimuli in highly trained athletes. The effects of exercise on arousal could be linked to neurophysiological changes such as level of plasma catecholamines with exercise duration or intensity (18).

Increased amount of blood flow in the brain results in improvements in cognitive functioning due to increased supply of necessary nutrients, such as oxygen and glucose (19). Improvement in VRT (Visual reaction time) over a period of time with practice was displayed in this study and supported the hypothesis. Reaction time in specific movements improves as a result of extensive practice of those concerned movements (19). Tripp claims that practice reduces decision time by eliminating incorrect decisions and enables the correct decision to be made more efficiently (20).

Due to increase in level of participation in specific events the reaction time tends to decrease. If an act is practiced enough a conditioned reflex may develop. For example, a sprinter may develop conditioned reflex to a pistol shot. Similar examples could be given in connection with numerous other performances and skills of different games and sports. Therefore reaction improving training sessions have to be held for athletes to develop their fine motor skills (19, 20).

Reaction times are widely used to evaluate neuromuscular-physiological responses in sports (21).

Reaction time is an important parameter for sports person's quickness and their performance. Improvement in reaction time will ultimately improve sports person's performance. Hence sports persons have to practice regularly to improve their reaction time and sports performance (22).

In a study done by Kaur et al they concluded that the reaction time is a good indicator of performance in sports as the athletes performed better with reaction time tasks (23). This study goes in hand with the study done by Brisswalter et al which states that physical exercise will decrease the reaction time (24). As exercise physiologists, our main aim is to improve the speed, skill and performance of the athlete. The above evidences suggest that speed and performance of an activity can be improved with faster reaction time to a stimulus. From the above findings of the study, faster reaction times can be achieved

by providing repeated auditory stimuli and with adequate periods of rest between the stimuli. A performance enhancing program can look like this: - Exposure to adequate auditory stimuli, repeated exposure to stimuli during practice, adequate periods of rest between practices (19). It can thus be concluded that RT is related to sprinters' mental activity and must be considered evidence of their racing strategy (25).

In the present study correlation analysis of reaction time with BMI has shown negative correlation for both auditory and visual reaction time with statistically significant value for green colour. Green color evoked a faster response due to its stronger stimulation on the visual receptor than for red color in both male and female subjects. The corpuscular theory of light, proposed by Max Plank explains the relationship between the wavelength and the energy carried by different colored lights. It indicates that one quantum of red light has the maximum wavelength and hence carries the least energy. The green light of same quantum has shorter wavelength and carries greater energy than red light. The greater energy carried by green light could be an important factor in stimulating the visual receptors faster, when compared to red light, producing a shorter response time (3, 26, 27). Lower the BMI, better is the reacting capability for sound and light, Negative correlation has been stated between BMI and RT according to study done by Dahl et al, Panya Jain and Deore DN (7). The study done by Simran et al, concludes that there is an indication for certain amount of sensorineural slowing and delay in CNS processing in obesity as suggested by increase in reaction time. This could be due to impairments of cognitive domains like attention & executive functions, vascular changes, myelin abnormalities along with axonal degeneration (28). Jain et al concludes that there is a significant increase in the reaction time as the weight of an individual increases beyond the normal range (7).

As BMI cannot distinguish between lean and fat body mass. Skinfold thickness may be a better predictor of body fatness. In our study Skin Fold Thickness showed a negative correlation with reaction time but was not statistically significant between runners and controls. Our literature search did not provide any other study giving the correlation of SFT with reaction time. One of the runners with 10 yrs of training had very less Skin Fold Thickness.

Conclusion

Reaction time improving training sessions have to be held for athletes to develop their fine motor skills and in turn to increase the performance. Decrease in BMI and SFT is essential to improve the reaction time and increase cognitive functions.

Limitations

In this study even though age and sex matching was done number of females were less for analysis on gender differences.

Larger sample size could have given better correlation of SFT and BMI.

References

1. Jain AK. Manual of practical physiology for MBBS. In: 4th Ed, Ch. 23.Reaction Time (Visual and Auditory) and Reflex Time. New Delhi: Avichal Publishing Company; 2012. p. 899.
2. Gavkare AM, Nanaware NL, Surdi AD. Auditory Reaction Time, Visual Reaction Time and Whole Body Reaction Time in Athletes. *Indian Medical Gazette* – June 2013; 214–217.
3. Das S, Gandhi A, Modal S. Effect of pre-menstrual stress on audiovisual reaction time & audiogram. *Ind J Physiol Pharmacol* 1997; 41: 67–70.
4. Baccouche MA, Arous I, Sellami H, Elloumi A. Association between Body Mass Index and Cognitive Performance in Rugby Players. International Journal of Scientific and Research Publications, Volume 4, Issue 6, June 2014; 1 ISSN 2250–3153.
5. Esmaeilzadeh S. Reaction Time: Does It Relate To Weight Status In Children? Journal Of Comparative Human Biology. APRIL 2014, .Jchb.2013.09.007, Http:// Www.Researchgate.Net/Publication/260440012
6. Dahl AK, Hassing LB, Fransson EI, Gatz M, Reynolds CA and Pedersen NL. Body mass index across midlife and cognitive change in late life. *Int J Obes (Lond)*. 2013 Feb; 37(2): 296–302.
7. Jain P, Gupta S, Vij V, Comparision of auditory and visual reaction time in normal weight, overweight and obese participants. World Journal of Pharmaceutical Research.

Volume 3, Issue 9, 869–876.

8. Deore DN, Surwase SP, Masroor S, Khan ST, Kathore V. A Cross Sectional Study on the Relationship Between the Body Mass Index (BMI) and the Audiovisual Reaction Time (ART). JCDR/2012/Nov/Volume(6)/Issue:9/1466–1468.
9. Cournot M, Marquie JC, Ansiau D, Martinaud C. Relation between body mass index and cognitive function in healthy middle aged men and women. *Neurology* 2006; 67: 1208–1214.
10. Giard MH, Peronnet F, Auditory-Visual Integration during Multimodal Object Recognition in Humans: A Behavioral and Electrophysiological Study, Journal of cognitive neuroscience, 1999; 11(5): 473–490.
11. Shenvi D, Balasubramanian P. A comparative study of visual and auditory reaction time in males and females. *Ind J Physiol Pharmacol* 1994; 38: 229–231.
12. Neumann G, Pfutzer A, Berbalk A. Successful Endurance Training. Page 152; Mayer and Mayer Sport Ltd.
13. Hoffmann J. Physiological Aspects of Sports Training and performance. Part II, Chapter 9, Page 111; Human Kinetics.
14. Johnson B Johnson BL, Nelson JK. Practical Measurements for Evaluation In physical Education. 3rd Ed. New Delhi: Surjeet publications; 1988.
15. Balady JG, Berra AK, Golding AL, Gordon FN, Mahler AD, Myers NJ et al. ACSM'S Guidelines for Exercise Testing and Prescription. 6th ed, Lippincott Williams and Wilkins.
16. Harpreet Kour et al. Assessment of audio-visual reaction time in drivers. *J Biosci Tech*, Vol 4(1), 2013; 508–512.
17. Taware GB, Bhutkar MV, Bhutkar PM, Doijad VP, Surdi AD. Effect of Age on Audio-Visual and Whole Body Reaction Time. *AJMS Al Ameen J Med Sci* (2012); 5(1): 90–94.
18. Mahesh K Bhabhor, Kalpesh Vidja, Priti Bhanderi, Shital Dodhia, Rajesh Kathrotia, Varsha Joshi. A comparative study of visual reaction time in table tennis players and healthy controls. *Indian J Physiol Pharmacol* 2013; 57(4): 439–442.
19. Jose Shelton, Gideon Praveen Kumar. Comparison between Auditory and Visual Simple Reaction Times, Neuroscience & Medicine, 2010; 1: 30–32.
20. Tripp RS. How fast can you react? *Science Digest* 57: 50, 1965.
21. Alina Meden, Marietta Wright MS, Bryan Hamilton. The Observance of the Visual Reaction Time of Non-Athletes Compared to Athletes. 2012 Bio Symposium poster, Department of Biology Waynesburg University, Waynesburg.
22. Tejas P. Ghuntla, Hemant B. Mehta, Pradnya A. Gokhale, Chinmay J. Shah, A comparison and importance of auditory and visual reaction time in basketball players. http://www.sjosm.org on Monday, September 21, 2015, IP: 122.183.241.170]
23. Prabhjot Kaur et al. Auditory and visual reaction time in athletes, healthy controls, and patients of type I diabetes mellitus: A comparative study, *Int J Diab Dev Ctries*, Vol. 26, Issue 3, Sept 2006.
24. J Brisswalter, R Arcelin. Influence of physical exercise on simple reaction time: effect of physical fitness. *Perceptual and Motorskills* 1997; 85: 1019–1027.
25. C Collet. Strategic aspects of reaction time In world-class sprinters. *Percepfzial ond motorskills*, 1999; 88: 65–75.
26. Shrikrishna N. Bamne, Ameet D. Fadia and Avantika V. Jadhav. Effect of colour and gender on human reaction time. 388 letter to editor. *Indian J Physiol Pharmacol* 2011; 55(4): 388–389.
27. Venkatesh D, Ramachandra DL, Baboo NS. Impact of psychological stress, gender and colour on visual response latency. *Ind J Physiol Pharmacol* 2000; 16: 333–337.
28. Grewal Simran, Walia Lily, Gupta Vidushi, Sekhon Tegbir S. Assessment of Auditory and Visual reaction time in healthy obese Indivisuals. *Journal of Advance Researches in Biological Sciences* 2013; Vol 5(1): 32–36.