Auditory and visual reaction time in athletes, healthy controls, and patients of type 1 diabetes mellitus: A comparative study

Prabhjot Kaur, Maman Paul, Jaspal Singh Sandhu

Department of Sports Medicine and Physiotherapy, Guru Nanak Dev University, Amritsar, India

BACKGROUND AND PURPOSE: Reaction time is one of the important methods used to study a person's central information processing speed and fast coordinated peripheral movement response. The purpose of this study was to compare the reaction time performances in controls, athletes, and patients of type 1 diabetes mellitus and to find out any gender differences.

METHODOLOGY: 120 subjects aged 20-30 years were distributed into three groups. Group I - Healthy controls, Group II - Athletes, Group III - Patients of type 1 diabetes mellitus. Equal number of males and females were taken. The reaction time was recorded for auditory and visual stimuli in seconds, by reaction time device.

RESULTS: Assessed by using unpaired 't' test. The athletes performed better than the controls and in the patients of Type 1 diabetes mellitus; there was a significant prolongation of the visual as well as auditory reaction times. However, gender differences were not observed.

CONCLUSION: It can be concluded that the reaction time is a good indicator of performance in sports, which suggests that diabetics participating in quick action sports should be careful about the injuries that may occur as a result of increased reaction time.

KEY WORDS: Athletes, reaction time, type I diabetes mellitus.

Introduction

The diabetic population is constantly on the rise.[1] Diabetics are also coming into competitive sports nowadays and most of them are those with Type 1 diabetes, which is commonly diagnosed in children and adolescents. Reaction time is often overlooked and usually under-estimated element in the preparation process for athletes. Athletes with diabetes present unique challenges with regard to their medication, education, and exercise recommendations. A player's ability to respond quickly, properly, and precisely to the information being sent is of utmost importance in determining success in the chosen sport.

Cognitive functions have been found to be affected with hyperglycemia by many researchers. In patients with Type 1 diabetes, cognitive dysfunction is characterized by a slowing of mental speed and a diminished mental flexibility.[2] Attention and fine motor skills assessed by the visual reaction time was found to be slowed at altered glucose levels.[3]

Purpose

The aim of the present study was to find out auditory and visual reaction time in athletes, healthy controls and patients of Type 1 diabetes mellitus (DM), to compare reaction time tasks of control with athletes and diabetic group, and investigate for gender differences in reaction time tasks.

Methodology

This is an experimental study with different subject design. Sample included 120 subjects aged 20-30 years, which were divided into three groups. Group I - 40 athletes (basketball players), Group II - 40 healthy controls, Group III - 40 patients of Type 1 DM. Equal number of males and females were taken.

The subjects included in the study were non-alcoholics, non-smokers having normal vision. They were not

Correspondence to **Dr. Prabhjot Kaur**, Department of Sports Medicine and Physiotherapy, Guru Nanak Dev University, Amritsar, Punjab, India. E-mail: prrrabh@yahoo.com

having any pathology or injury to the upper limb and were not suffering from any psychiatric disorder affecting their psychomotor abilities. Each of these conditions could be responsible in affecting reaction time performance and could become a confounding factor in the study. In diabetic patients, the blood glucose should be well controlled and the mean duration of diabetes should be ≥10 years. The subjects with mental, psychological disorder and those patients of diabetes having clinical evidence of peripheral neuropathy, muscle weakness, and neurovascular complications were excluded. The subjects were informed about the nature of the study and a written consent was obtained.

The present study was conducted on 'Audio-visual reaction time apparatus RTM 608' by Medicaid systems. The instrument has a resolution of 0.001 sec and accuracy of +1 digit. It has two modes of providing stimulus- audio stimulus (continuous sound on speaker) and visual stimulus (shooting red, yellow and green lights). The reaction time was recorded for auditory low and high frequency sound stimuli and visual reaction time for red, green and yellow light stimuli. As soon as the stimuli was perceived by the subject, he responded by pressing the response switch by the index finger of the dominant hand. The display indicated the response time in seconds. They were given 10 trials and after repeated practice, three readings for each parameter were noted. The average of three readings was taken as the value for reaction time task and was noted in the subject's record profile.

Results

Data are summarized using mean and standard deviation [Tables 1-2 and Figures 1-2]. Unpaired'*t*' test was used to analyze the data. For statistical analysis, the software Statistical Package Social Sciences SPSS (Version 14.0) was used. The level of significance was set at $P \leq 0.05$ for all comparisons.

On inter-group comparison between diabetics and controls, statistically significant results were found. Controls performed better than diabetic group for auditory low and high frequency sound stimuli and visual reaction time for red, green, and yellow light stimuli (at $P < 0.001$ for both males and females).

On comparison between athletes and controls, statistically significant differences were found, for low frequency (at $P < 0.05$ in males and females), for high frequency (at $P < 0.05$ for males) auditory reaction time; and also in visual reaction time for red, green and yellow light stimuli ($P < 0.05$ in males).

No statistically significant differences were found in reaction time performances between males and females in each group.

Discussion

The most important finding of the present study was the difference in performance of the three groups of the

Table 1: Comparison of auditory reaction time in three groups

Audio reaction time		Controls mean ± SD	Athletes mean ± SD	Diabetes mean ± SD
High	Male	0.1795 ± 0.128	0.1614 ± 0.175*	0.2531 ± 0.175**
Frequency	Female	0.1802 ± 0.167	0.1699 ± 0.180	0.2561 ± 0.505**
Low	Male	0.1852 ± 0.219	0.1643 ± 0.162*	0.2599 ± 0.468**
Frequency	Female	0.1821 ± 0.168	0.1704 ± 0.180*	0.2595 ± 5.77**

*$P < 0.05$, **$P < 0.001$

Table 2: Comparison of visual reaction time in three groups

Audio reaction time		Controls mean ± SD	Athletes mean ± SD	Diabetes mellitus mean ± SD
Red	Male	0.1889 ± 0.205	0.1614 ± 0.183*	0.2667 ± 0.489**
Stimuli	Female	0.1897 ± 0.201	0.1751 ± 0.192*	0.2684 ± 0.526**
Green	Male	0.1931 ± 0.216	0.1709 ± 0.179*	0.2721 ± 0.490**
Stimuli	Female	0.1953 ± 0.217	0.1772 ± 0.180*	0.2734 ± 0.524**
Yellow	Male	0.1941 ± 0.212	0.1690 ± 0.179*	0.2734 ± 0.494**
Stimuli	Female	0.1932 ± 0.209	0.1808 ± 0.204	0.2792 ± 0.570**

*Signifies $P < 0.05$, **Signifies $P < 0.001$

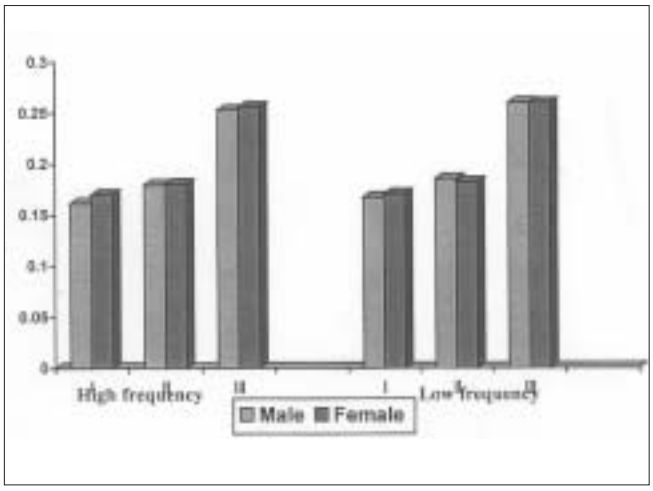

Figure 1: Comparison of auditory reaction time between three groups

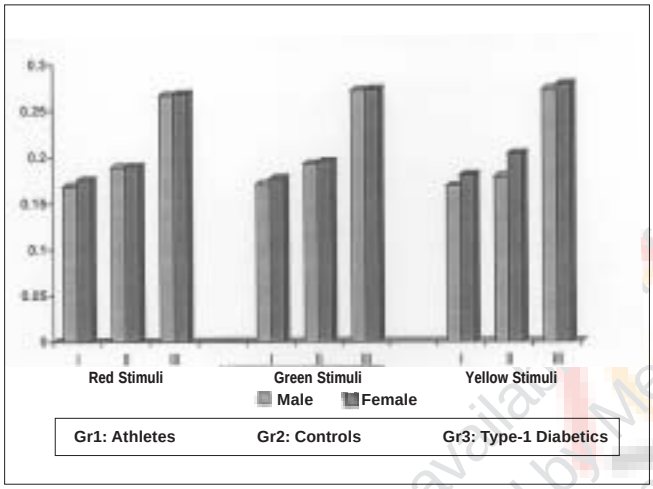

Figure 2: Comparison of visual reaction time between three groups

subjects under the study; the athletes, the healthy controls and the diabetic group.

The finding of the study revealed that reaction time for auditory stimuli as shown in Figures 1 and for visual stimuli as shown in Figures 2 was found to be prolonged in diabetes mellitus group when compared to controls and athletes. The possible mechanism for this finding could be due to high blood glucose associated with diabetes that causes chemical changes in the nerves and damages blood vessels that carry oxygen and nutrients to the nerves. Excessive glucose metabolism causes decrease in nitric oxide in nerves that dilates blood vessels and low levels of nitric oxide may lead to constriction of blood vessels supplying the nerves in diabetic patients. Raised blood glucose affects many metabolic pathways in the nerves leading to an accumulation of sorbitol and depletion of myoinositol. These changes impair the nerve's ability to transmit signals.

The axonal degeneration of both myelinated and unmyelinated fibres, axon shrinkage, axonal fragmentation, thickening of basement membrane and microthrombi are responsible for the delayed motor nerve conduction velocity[4,5] and hence, the increased reaction time.

The clinical significance of such subtle alterations is speculative. Probably such alterations might prove deleterious in subjects required to take instantaneous decisions in quick action sports such as boxing and basketball.

The quicker reaction time in athletes as compared to control is due to improved concentration, alertness, better muscular co-ordination and improved performance in the speed and accuracy task. The exercise induces arousal that supports alertness to external environmental stimuli in higher trained athletes.[6] Exercise increased activation of central nervous system and could facilitate cognitive processes. The effects of exercise on arousal could be linked to neurophysiological changes such as level of plasma catecholamines with exercise duration or intensity.

Exercise training elicits an adaptive increase in mitochondrial content and respiratory capacity of those skeletal muscles that were being used during the exercise training leading to sparing of glycogen and increased capacity to oxidize fatty acid, thus prolongation in work time, delay in fatigue, increase in enzymatic activity and increasing oxidation of ketones and its removal.[7] Thus, these beneficial effects in players are responsible for their faster reaction time performance.

In the present study, no significant gender differences were observed. However males performed better than females in some reaction time tasks but this was statistically insignificant.

Conclusion

It can be concluded that the reaction time is a good indicator of performance in sports as the athletes performed better in the reaction time tasks and suggests that diabetics participating in quick action sports should be careful about the injuries that may occur as a result of increased reaction time.

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Announcement

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