Australian Journal of Basic and Applied Sciences

2023 January; 17(1): pages 9-14
https://doi.org/10.22587/ajbas.2023.17.1.2

ORIGINAL ARTICLE AENSI PUBLICATIONS

An Examination of Audio-Visual Simple Reaction Times in Selected Court Games

Md. Nasim Reza[1*], Md. Hamidur Rahman[2], Muhammad Shahidul Islam[3], Arup Gayen[4]

[1] Professor, Department of Physical Education and Sports Science, Faculty of Health Science, Jashore University of Science and Technology, Jashore, Bangladesh
[2]Assistant Professor, Department of Physical Education and Sports Science, Faculty of Health Science, Jashore University of Science and Technology, Jashore, Bangladesh
[3]Deputy Director, Office of Physical Education, Shahjalal University of Science and Technology, Sylhet, Bangladesh
[4]Assistant Professor, Department of Physical Education, Saheed Anurup Chandra Mahavidyala (Calcutta University), West Bengal, India

Correspondence Author: Md. Nasim Reza, Professor, Department of Physical Education and Sports Science, Faculty of Health Science, Jashore University of Science and Technology, Jashore- 7408, Bangladesh.
E-mail: drmdnasimreza@gmail.com
https://orcid.org/0000-0002-1599-3389

Received date: 15 November2022, Accepted date: 23 January2023

Citation: M. N. Reza., M. H. Rahman., M. S. Islam., A. Gayen.,.2023. An Examination of Audio-Visual Simple Reaction Times in Selected Court Games. Australian Journal of Basic and Applied Sciences, 17(1): 9-14. DOI: 10.22587/ajbas.2023.17.1.2.

ABSTRACT: This research examined the audio-visual simple reaction times in the hands and legs of basketball, handball, and volleyball players. A total of thirty-six (N=36) male athletes randomly participated in this study, among them (n=12) basketball players, (n=12) handball players, and (n=12) volleyball players. The players' average ages were 22.33±1.15; 22.00±1.41; 21.75±1.22, and they competed at the university level in their respective sports. The timer for Audio-Visual Reaction was used to measure the auditory and visual simple reaction times of the hands and legs in milliseconds. The mean, standard deviation, independent t-test, and one-way ANOVA were used, and the level of significance was set at p<0.05. The F-value of auditory reaction time was 0.21 (> 0.05) in basketball, handball, and volleyball players' strong hand, 0.05 (> 0.05) in weak hand, 1.02 (> 0.05) in strong leg, and 2.23 (> 0.05) in weak leg. Whereas, the strong hand had a visual reaction time of 1.37 (> 0.05), the weak hand had a reaction time of 0.51 (> 0.05), the strong leg had a reaction time of 2.31 (> 0.05), and the weak leg had a reaction time of 0.65 (> 0.05). According to the statistical examination, no significant difference was obtained in auditory and visual reaction times among basketball, handball, and volleyball players with their strong and weak hands and strong and weak legs. Since there was no significant difference in the ANOVA analysis, the reaction times of the limbs (auditory and visual) were compared between each of the two games. The weak leg auditory reaction time was significantly different between basketball and handball players in an independent t-test (t (22) = 2.17, sig. = 0.041 at p 0.05). This study concluded that the auditory and visual simple reaction ability of hands and legs was closer for the three different court games, and a difference was obtained between basketball and handball players concerning weak leg auditory reaction time.

Keywords: Reaction time, Audio-visual, Court games, Hands and Legs, Basketball, Handball, Volleyball

INTRODUCTION

Reaction time is crucial in court games where an athlete's movements are influenced by signals, opponents' actions, or the ball's motion (Jyothi et al., 2016). Different court games necessitate total engagement of rapid movements and physical, technical, mental, and tactical abilities (Miftari et al., 2018). Due to the general length of these games, team players must possess all core motoric abilities, including strength, speed, durability, mobility, dexterity, and coordination (Akyüz et al., 2016). Players are exposed to both high and low levels of external load during games. On the other hand, the court game's external load is separated into acyclic and cyclic movements. Acyclic actions (e.g., passing the ball, various types of shots, hops, body contacts, and falls)

occur alongside the player's cyclic motions in these situations (running, walking, jogging, traveling, and moving side or backward) (Šibilaet al., 2004). However, reaction time and hand-eye coordination are considered essential for success in numerous sports, including court games, team sports, racket sports, combat sports, and individual sports (Menevşe, 2011; Örset al., 2019). Combat sports are excellent examples of activities in which response time is critical in determining victory (Lenik et al., 2017; Mori et al., 2002). It might be noted that both combat sports and court games require a small area to play, and success is dependent on quick reaction time. Somewhere athletes must reply to various stimuli in various situations; response time is one of the factors in a great result, and athletes with similar physical and technical skills with shorter reaction times are more effective (Temur & Baytar, 2019). The majority of the action in the games is done through the use of auditory and visual information. Athletes employ audio and visual information to communicate with their teammates during various sporting situations, and reaction time is a critical assessment tool in this environment (Rahman & Islam, 2021).

Simple reaction time (SRT) refers to a quick response to a particular stimulus (Chandra et al., 2010; Badau et al., 2018). For example, the amount of time required to respond to audio and visual stimuli is known as auditory and visual reaction time (Ghuntla et al., 2014). The speed and performance of an activity can be increased by having a faster reaction time to a stimulus. It is feasible to achieve faster reaction times by repeatedly delivering auditory stimuli with adequate rest periods in between (Shelton & Kumar, 2010). Depending on the action, a stimulus in sports could be optical, aural, or tactile. The athlete's brain swiftly interprets the message and reacts by delivering the information to the proper muscles via the nervous system, causing a contraction once the message is recognised by the sense organs ('Reaction Time in Sports', 2019). However, depending on the game situation, two forms of reaction time are utilised in sports: simple and complex reaction time.

Consequently, the time required to reply to single stimuli is referred to as simple reaction time (BlazePod, n.d.). Previous research discovered that simple reaction time was linked to physical fitness in a substantial way (Reigal et al., 2019). Therefore, the audio-visual simple reaction time in the hands and legs of basketball, handball, and volleyball players in Bangladesh was investigated in the current study.

Although there are studies comparing auditory and visual reaction time in a few court games, no studies have been found comparing auditory and visual simple reaction time in basketball, handball, or volleyball. However, playing with the ball and using hands and legs are crucial in these three games. As a result, this study aimed to evaluate the hands and legs of basketball, handball, and volleyball players' auditory and visual simple reaction times.

MATERIALS AND METHODS

Thirty-six (N = 36) male athletes (12 basketball players, 12 handball players, 12 volleyball players) voluntarily participated in this study. The subjects were between the ages of 17 and 24 years and competed in their respective sports at the inter-university level. All subjects were regular undergraduate students and were selected from Bangladesh's Jashore areas. Audio Visual Reaction Timer manufactured by Medisystems, Jagadhri, Haryana 135003, India, was used to assess auditory and visual simple reaction time (*Audio Visual Reaction Timer – Medi Systems India*, n.d.).

The apparatus has two sides: an experimenter side and a subject side. A sheet separates two sides. Light and sound are the two modalities of operation. Light signals were used to capture visual data, while sound signals were used to collect auditory data. The switches on the experimenter's side are set to glow with light, and the subject is instructed to turn them off as quickly as possible. During audio-visual data on the hands and legs, the subjects were comfortable sitting. When data were collected by hand, a timer device was placed on the table, and the participant was instructed to keep the switch off at the preferred figure. In the case of leg data collection, the timer device was placed on the ground and the participant was instructed to keep it off with his thumb. The subjects' reaction time is recorded on the timer. Milliseconds (ms) are used to measure time intervals on this timer. The final data was gathered from five trials. Everyone in the study was a right-handed player. Each subject was asked which hand he preferred for tasks like eating, combing his hair, brushing his teeth, and writing. The participants were also asked which foot they preferred to kick a ball with (Misra et al., 1985). This study's preferred hand and leg are referred to as strong hand and leg.

Descriptive statistics, mean, standard deviation (SD), standard error (SE), one-way analysis of variance (ANOVA), and independent t-test were computed by means of SPSS software version 26 for Windows; IBM, Chicago, IL, USA. The significance level was set at $p<0.05$.

RESULTS

Table 1 shows that the auditory simple reaction time of basketball, handball, and volleyball players mean and SD of the strong hand was 156.00±24.42 ms, 152.42±26.97 ms, 158.58±18.00 ms, and the weak hand was 177.08±39.24 ms, 176.50±19.09 ms, and 173.25±38.58 ms respectively. Whereas the strong leg was 181.42±24.08 ms, 179.33±26.22 ms, 195.08±36.38 ms, and the weak leg was 224.75±34.33 ms, 191.33±40.82 ms, and 201.42±43.65 ms respectively.

Table 1: Descriptive statistics of basketball, handball, and volleyball players on auditory simple reaction time

Parameters	Players (n=12)	Mean (ms)	Std. Deviation(ms)	Std. Error
Strong Hand	Basketball	156.00	24.42	7.05
	Handball	152.42	26.97	7.79
	Volleyball	158.58	18.00	5.20
Weak Hand	Basketball	177.08	39.24	11.33
	Handball	176.50	19.09	5.51
	Volleyball	173.25	38.58	11.14
Strong Leg	Basketball	181.42	24.08	6.95
	Handball	179.33	26.22	7.57
	Volleyball	195.08	36.38	10.50
Weak Leg	Basketball	224.75	34.33	9.91
	Handball	191.33	40.82	11.78
	Volleyball	201.42	43.65	12.60

Table 2 shows that the visual simple reaction time of basketball, handball, and volleyball players mean and SD of the strong hand was 177.58±13.37 ms, 167.75±25.10 ms, 182.92±27.27 ms, and weak hand was 188.50±28.66 ms, 177.83±26.88 ms, and 188.50±33.79 ms respectively. Whereas the strong leg was 243.75±74.53 ms, 198.75±32.62 ms, 209.92±44.19 ms, and the weak leg was 230.08±46.64 ms, 210.58±36.93 ms, and 224.58±45.76 ms respectively.

Table 2: Descriptive statistics of basketball, handball, and volleyball players on visual simple reaction time

Parameters	Players (n=12)	Mean (ms)	Std. Deviation(ms)	Std. Error
Strong Hand	Basketball	177.58	13.37	3.86
	Handball	167.75	25.10	7.25
	Volleyball	182.92	27.27	7.87
Weak Hand	Basketball	188.50	28.66	8.27
	Handball	177.83	26.88	7.76
	Volleyball	188.50	33.79	9.76
Strong Leg	Basketball	243.75	74.53	21.52
	Handball	198.75	32.62	9.42
	Volleyball	209.92	44.19	12.76
Weak Leg	Basketball	230.08	46.64	13.46
	Handball	210.58	36.93	10.66
	Volleyball	224.58	45.76	13.21

Table 3 shows the auditory simple reaction time of basketball, handball, and volleyball players' strong hand, weak hand, strong leg, and weak leg. The strong hand was $p = 0.812$ ($F = 0.21$), weak hand $p = 0.956$ ($F = 0.05$), strong leg $p = 0.373$ ($F = 1.02$), and weak leg $p = 0.124$ ($F = 2.23$). There were no significant differences in the auditory simple reaction time of hands and legs between the three team sports players ($p > 0.05$).

Table 3: One-way ANOVA of basketball, handball, and volleyball players on auditory simple reaction time

Parameters	Variation	Sum of Squares	df	Mean Square	F-ratio	p-value
Strong Hand	Between Groups	230.17	2	115.08	0.21	0.812
	Within Groups	18129.83	33	549.39		
Weak Hand	Between Groups	102.39	2	51.19	0.05	0.956
	Within Groups	37312.17	33	1130.67		
Strong Leg	Between Groups	1756.72	2	878.36	1.02	0.373
	Within Groups	28502.50	33	863.71		
Weak Leg	Between Groups	7051.17	2	3525.58	2.23	0.124
	Within Groups	52257.83	33	1583.57		

Significant at the 0.05 level; F 0.05 (2, 33) = 3.285

Table 4 shows the simple visual reaction time of basketball, handball, and volleyball players' strong hand, weak hand, strong leg, and weak leg. The strong hand was $p = 0.268$ ($F = 1.37$), weak hand $p = 0.606$ ($F = 0.51$), strong leg $p = 0.116$ ($F = 2.31$), and weak leg $p = 0.531$ ($F = 0.65$). No significant differences were found between the three different team players in the visual simple reaction time of hands and legs ($p>0.05$).

Table 4: One-way ANOVA of basketball, handball, and volleyball players on visual simple reaction time

Parameters	Variation	Sum of Squares	df	Mean Square	F-ratio	p-value
Strong Hand	Between Groups	1420.67	2	710.33	1.37	0.268
	Within Groups	17078.08	33	517.52		
Weak Hand	Between Groups	910.22	2	455.11	0.51	0.606
	Within Groups	29545.67	33	895.32		
Strong Leg	Between Groups	13177.56	2	6588.78	2.31	0.116
	Within Groups	94295.42	33	2857.44		
Weak Leg	Between Groups	2426.00	2	1213.00	0.65	0.531
	Within Groups	61964.75	33	1877.72		

Significant at the 0.05 level; F 0.05 (2, 33) = 3.285

Table 5 of the independent t-test on auditory simple reaction time between basketball & handball, basketball & volleyball, and handball & volleyball players shows that the strong hand of basketball & handball players $t_{(22)}$ = 0.34, sig. = 0.737; basketball & volleyball players $t_{(22)}$ = 0.29, sig. = 0.774; handball & volleyball players $t_{(22)}$ = 0.66, sig. = 0.516; and the weak hand of basketball & handball players $t_{(22)}$ = 0.05, sig. = 0.961; basketball & volleyball players $t_{(22)}$ = 0.24, sig. = 0.813; handball & volleyball players $t_{(22)}$ = 0.26, sig. = 0.797. Whereas the strong leg of basketball & handball players $t_{(22)}$= 0.20, sig. = 0.843; basketball & volleyball players $t_{(22)}$= 1.09, sig. = 0.288; handball & volleyball players $t_{(22)}$= 1.22, sig. = 0.235; and the weak leg of basketball & handball players $t_{(22)}$= 2.17, sig. = 0.041; basketball & volleyball players $t_{(22)}$= 1.46, sig. = 0.158; handball & volleyball players $t_{(22)}$= 0.58, sig. = 0.568. The results show that the mean difference in auditory simple reaction time between basketball and handball players is significant at the 0.05 level in relation to weak leg auditory reaction time.

Table 5: Independent t-test of limbs between basketball, handball, and volleyball players on auditory simple reaction time

Limbs	Basketball	Handball	Volleyball	*t*	*df*	*Sig. (2-tailed)*
Strong Hand	156.00	152.42		0.34	22	0.737
	156.00		158.58	0.29	22	0.774
		152.42	158.58	0.66	22	0.516
Weak Hand	177.08	176.50		0.05	22	0.961
	177.08		173.25	0.24	22	0.813
		176.50	173.25	0.26	22	0.797
Strong Leg	181.42	179.33		0.20	22	0.843
	181.42		195.08	1.09	22	0.288
		179.33	195.08	1.22	22	0.235
Weak Leg	224.75	191.33		2.17	22	0.041
	224.75		201.42	1.46	22	0.158
		191.33	201.42	0.58	22	0.568

Significance level at 22 df at 0.05 level = 2.074

Table6 of the independent t-test on visual simple reaction time between basketball & handball, basketball & volleyball, and handball & volleyball players shows that the strong hand of basketball & handball players $t_{(22)}$ = 1.20, sig. = 0.243; basketball & volleyball players $t_{(22)}$ = 0.61, sig. = 0.548; and handball & volleyball players $t_{(22)}$ = 1.42, sig. = 0.170; and the weak hand of basketball & handball players $t_{(22)}$ = 0.94, sig. = 0.357; basketball & volleyball players $t_{(22)}$ = 0.00, sig. = 1; handball & volleyball players $t_{(22)}$ = 0.86, sig. = 0.399. Whereas the strong leg of basketball & handball players $t_{(22)}$ = 1.92, sig. = 0.679; basketball & volleyball players $t_{(22)}$ = 135, sig. = 0.191; handball & volleyball players $t_{(22)}$ = 0.70, sig. = 0.491; and the weak leg of basketball & handball players $t_{(22)}$ = 1.44, sig. = 0.266; basketball & volleyball players $t_{(22)}$ = 0.29, sig. = 0.774; handball & volleyball players $t_{(22)}$ = 0.82, sig. = 0.421. According to the statistical study, no significant difference was obtained in the visual simple reaction time between basketball & handball, basketball & volleyball, and handball & volleyball players with their strong hand, weak hand and strong leg, weak leg.

Table 6: Independent t-test of limbs between basketball, handball, and volleyball players on visual simple reaction time

Limbs	Basketball	Handball	Volleyball	*t*	*df*	*Sig. (2-tailed)*
Strong Hand	177.58	167.75		1.20	22	0.243
	177.58		182.92	0.61	22	0.548
		167.75	182.92	1.42	22	0.170
Weak Hand	188.50	177.83		0.94	22	0.357
	188.50		188.50	0.00	22	1
		177.83	188.50	0.86	22	0.399
Strong Leg	243.75	198.75		1.92	22	0.679
	243.75		209.92	1.35	22	0.191
		198.75	209.92	0.70	22	0.491
Weak Leg	230.08	210.58		1.14	22	0.266
	230.08		224.58	0.29	22	0.774
		210.58	224.58	0.82	22	0.421

Significance level at 22 df at 0.05 level = 2.074

DISCUSSION

This is the first study in Bangladesh to explore differences in simple reaction time among three different court games: basketball, handball, and volleyball. We analyse both limbs to evaluate the hands and legs of basketball, handball, and volleyball players' auditory and visual simple reaction times since these three games require both hands and legs to perform better. As shown in tables 3 and 4, there are no significant differences in auditory and visual simple reaction time between the strong hand, weak hand, strong leg, and weak leg of basketball, handball, and volleyball players. Table 5 shows that the auditory simple reaction time of the weak leg was significant between basketball and handball players. Also, Table 6 shows that no significant difference was obtained in the visual simple reaction time between basketball and handball, basketball and volleyball, and handball and volleyball players with their strong hand, weak hand, strong leg, and weak leg. A previous study compared players from similar sports to the limbs of badminton, tennis, and table tennis and discovered that there is no significant difference in simple audio-visual response time among competitors in this branch (Kaplan et al., 2019). However, another study discovered that soccer goalkeepers, cricket wicketkeepers, and kho-kho players all have different hand reaction times (Gayen et al., 2014). An earlier study demonstrated a substantial decrease in auditory and visual reaction time in basketball players compared to healthy controls (Gawre et al., 2020), implying that athletes have faster reaction times than non-athletes. Therefore, the current researchers wanted to determine if there are any differences in simple reaction time between the limbs of court game players. According to Shejwal and Kumar, soccer-playing collegiate players have a faster reaction time than volleyball-playing collegiate athletes, demonstrating that the field game has a shorter reaction time than the court game (Shejwal & Kumar, 2020). Table tennis, on the other hand, is a small-space activity that helps with eye-hand coordination, attention, and awareness. Also, table tennis significantly impacts reaction time reduction (Bhabhor et al., 2013). Another study found that regular sports activity reduces response time, which is a good predictor of the rate at which the central nervous system processes sensory data. Similarly, playing badminton has an effect on reducing reaction time (Dube et al., 2015; Yüksel & Tunç, 2018; Hülsdünker et al., 2021). However, the auditory reaction time is faster than the visual reaction time because the auditory stimulus reaches the cortex faster than the visual signal. In sports, reaction time is a good predictor of quickness. Athletes with faster reaction times have a better chance of succeeding (Ghuntla et al., 2014). Given a result, current researchers were keen to learn which court game has the shortest reaction time, as all three games require eye-hand coordination and are nearly identical. Finally, all court games have similar response times, except for the auditory simple reaction time of the weak leg, which differed significantly between basketball and handball players, according to the findings of this study.

CONCLUSION

This study concluded that the auditory and visual simple reaction times by the hands and legs are closer in the basketball, handball, and volleyball branches. However, the difference between basketball and handball players was significant concerning weak leg auditory simple reaction time. The weak leg auditory simple reaction time of handball players in Bangladesh was better than the auditory simple reaction time of basketball players.

ACKNOWLEDGEMENT

The authors express their gratitude to all participants who contributed to the study.

Funding Information:

Not available.

Conflicts of interest:

The authors declare no conflict of interest.

REFERENCES

Akyüz, M., Uzaldi, B. B., Akyüz, Ö.,& Doğru, Y. (2016). Comparison of sprint reaction and visual reaction times of athletes in different branches. *Journal of Education and Training Studies*, *5*(1), 94-100. https://doi.org/10.11114/jets.v5i1.1987

Audio Visual Reaction Timer – Medi Systems India.(n.d.). Retrieved 10 April 2022, from https://medisystemsindia.com/product/audio-visual-reaction-timer/

Badau, D., Baydil, B., & Badau, A. (2018). Differences among three measures of reaction time based on hand laterality in individual sports. *Sports (Basel, Switzerland)*, *6*(2), E45, 1-6. https://doi.org/10.3390/sports6020045

Bhabhor, M. K., Vidja, K., Bhanderi, P., Dodhia, S., Kathrotia, R., & Joshi, V. (2013). A comparative study of visual reaction time in table tennis players and healthy controls. *Indian Journal of Physiology and Pharmacology*, *57*(4), 439–442

Blaze Pod.(n.d.). *Different Types of Reaction Time in Sports*. Blaze Pod. Retrieved 10 April 2022, from https://www.blazepod.com/blogs/resources/different-types-of-reaction-time-in-sports

Chandra, A. M., Ghosh, S., Barman, S., Iqbal, R., & Sadhu, N. (2010). Effect of exercise and heat-load on simple reaction time of university students. *International Journal of Occupational Safety and Ergonomics: JOSE*, *16*(4), 497–505. https://doi.org/10.1080/10803548.2010.11076862

Dube, S. P., Mungal, S. U., & Kulkarni, M. B. (2015). Simple visual reaction time in badminton players: A comparative study. *National Journal of Physiology, Pharmacy and Pharmacology*, *5*, 18–20. https://doi.org/10.5455/njppp.2015.5.080720141

Gawre, V. V., Dhule, S. S., Gore, C. V., & Hundergulle, S. (2020). Auditory reaction time and visual reaction time in basketball players of Ambajogai Maharashtra. *MedPulse International Journal of Physiology. 13*(3), 30-32. https://doi.org/10.26611/1031331

Gayen, A., Mitra, S., & Bandyopadhyay, S. (2014). Assessment of reaction time of soccer goalkeepers wicketkeepers in cricket and kho-kho players. *Indian Journal of Applied Research, 4*(2), 30-31

Ghuntla, T. P., Mehta, H. B., Gokhale, P. A., & Shah, C. J. (2014). A comparison and importance of auditory and visual reaction time in basketball players. *Saudi Journal of Sports Medicine, 14*(1), 35-38. https://doi.org/10.4103/1319-6308.131616

Hülsdünker, T., Riedel, D., Käsbauer, H., Ruhnow, D., & Mierau, A. (2021). Auditory information accelerates the visuomotor reaction speed of elite badminton players in multisensory environments. *Frontiers in Human Neuroscience*, *15*, 779343. https://doi.org/10.3389/fnhum.2021.779343

Jyothi, S., Vernekar, S. S., Manishankar, null, Vinothkumar, L. J., & Rashmi, R. (2016). Correlation of audio-visual reaction time with body mass index & skin fold thickness between runners and healthy controls. *Indian Journal of Physiology and Pharmacology*, *60*(3), 239–246

Kaplan, D. S., Yıldırım, C., Akcan, F., Özdal, M., Abakay, Z., & Bağçeci, A. M. (2019).The investigation of visual and auditory reaction time in racket sports by skills and sedentary. *European Journal of Physical Education and Sport Science*, *5*(5), 11-18. https://doi.org/10.46827/ejpe.v0i0.2253

Lenik, P., Przednowek, K., Śliż, M., Bobula, G., & Lenik, J. (2017, December 30). The impact of exercises with a reaction ball on the eye-hand coordination of basketball players.pilot study. *Proceedings of the 11th International Conference on Kinanthropology.* Masaryk University. (pp. 353-364). https://public.ebookcentral.proquest.com/choice/PublicFullRecord.aspx?p=6913523

Menevşe, A. (2011). Examination of the relationship between muscle palmaris longus and reaction time. *World Applied Sciences Journal*, *12*(1), 114-118

Miftari, F., Selimi, M., & Salihu, H. (2018). Differences in some anthropometric parameters between basketball, handball and volleyball elite athletes in kosovo. *Bulletin of the Transilvania University of Braşov: Series IX Sciences of Human Kinetics*, *11(60)*(1), 63–70

Misra, N., Mahajan, K. K., & Maini, B. K. (1985). Comparative study of visual and auditory reaction time of hands and feet in males and females. *Indian Journal of Physiology and Pharmacology*, *29*(4), 213–218

Mori, S., Ohtani, Y., & Imanaka, K. (2002). Reaction times and anticipatory skills of karate athletes. *Human Movement Science*, *21*(2), 213–230. https://doi.org/10.1016/s0167-9457(02)00103-3

Örs, B. S., Cantaş, F., Güngör, E. O., & ŞimşeK, D. (2019). Assessment and comparison of visual skills among athletes. *Journal of Sports and Performance Researches*,*10*(3), 231-241. https://doi.org/10.17155/omuspd.522342

Rahman, M. H., & Islam, M. S. (2021). Investigation of audio-visual simple reaction time of university athletes and non-athletes. *Journal of Advances in Sports and Physical Education*, *4*(3), 24-29. https://doi.org/10.36348/jaspe.2021.v04i03.002

Reaction Time in Sports. (2019, September 20). *The Sports Edu*. https://thesportsedu.com/reaction-time-definition/

Reigal, R. E., Barrero, S., Martín, I., Morales-Sánchez, V., Juárez-Ruiz de Mier, R., & Hernández-Mendo, A. (2019). Relationships between reaction time, selective attention, physical activity, and physical fitness in children.*Frontiers in Psychology*, *10*, 2278. https://doi.org/10.3389/fpsyg.2019.02278

Shejwal, K., & Kumar, N. (2020). Comparison of simple reaction time between volleyball and football playing collegiate athletes. *International Journal of Research and Review. 7*(2), 421-424

Shelton, J., & Kumar, G. P. (2010). Comparison between auditory and visual simple reaction times. *Neuroscience and Medicine*, *1*(1), 30–32. https://doi.org/10.4236/nm.2010.11004

Šibila, M., Vuleta, D., & Pori, P. (2004). Position-related differences in volume and intensity of large-scale cyclic movements of male players in handball.*Kinesiology*, *36*(1.), 58–68. https://hrcak.srce.hr/4221

Temur, H. B., & Baytar, R. (2019). Comparison of the reaction time period of individuals in sport, fine arts and classroom education.*Asian Journal of Education and Training*, *5*(3), 495–500. https://doi.org/10.20448/journal.522.2019.53.495.500

Yüksel, M. F., & Tunç, G. T. (2018). Examining the reaction times of international level badminton players under 15. *Sports (Basel, Switzerland)*, *6*(1), E20. https://doi.org/10.3390/sports6010020