A Complete Exercise Protocol to Decrease Reaction Time

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Abstract
Background: Elite badminton players has shortest reaction time (RT) in comparison to the Recreational Badminton Players (RBP). There are none established exercise protocol which reports decline in RT in RBP. The present study is aimed to study the effectiveness of physiotherapy protocol on RT in RBP. **Methods**: This will be single group pre-test and post-test feasiblity trial. Sixteen male and female RBP's aged 11-17 year, will be recruited by purposive sampling. After screening and assessment, reaction time will be assessed by Ruler drop test (RDT). Then participants will receive intervention including One Leg Forward Jump, Plank Jacks, Side Shuffles, 5-10-5 Drill etc with cool down and warm up session for 4 weeks. After 4 weeks reaction time will be assessed again by RDT test will be used to assess the reaction time. **Discussion:** This section discusses the decision to publish a trial protocol
Keywords: Reaction Time, Recreational Player, And Badminton;

Background

Reaction time (RT) is a very relevant variable in various areas such as sports, academics and many other tasks of daily living (Metin B et al., 2016). RT is the time difference between the stimulus and response (Jesen A et al., 2006). Reaction time varies according to the expertise level in badminton (De Waelle., et al 2022). Reaction time (RT) is one of the foremost variable in distinct areas for instance sports, academics, and other various different tasks of daily living (Adleman., et al 2016). The time that elapses between the stimulus appearance and until the given response is defined as RT (Jensen, A., 2006). As far studies shows, elite player requisite shorter reaction time in comparing to the recreational players (Sushil P Dube., 2015) . Recreational player (RP) spot the game in the form of "entertainment" and less frequently with shorter session and like to take the risk for entertainment and RP might make reckless, hasty, illogical decisions during the game (Cormac Ma., 2012). Badminton is one of the most fastest and exhausting racket sport played around the world, which was derive from the China and founded in England (Kwan M et al., 2008) (Lo et al., 1991). Badminton could be practiced independently or in doubles at any age (Lo et al., 1991). The badminton booms from 1992 when it entered in Olympics (Cabello Manrique., 2003). Performance varies of every individual according to anthropometric measurement such as to individual depending upon the characteristics divulge the correlation between body structures, bone mass, physical characteristics etc (Phomsoupha et al., 2015) . Ruler drop test (RDT) is well-established functional test to assess simple clinical reaction time[12,13]. Ruler Drop Test (RDT) is the gold standard functional tool to assess the simple RT (Phomsoupha et al., 2015). Ruler drop test have acceptable interrater reliability (intraclass correlation coefficient [ICC]=0.74) and adequate test retest reliability (ICC range = 0.65-0.86) (Del Rossi G., 2017)

(Eckner et al., 2015). As far studies found in elite players has shortest reaction time in comparison to the recreational players (non-professional players), (Reigal et al., 2019) recreational players are not much disciplined than professional players (Abby McCormack et al., 2012). Badminton is the amalgam of aerobic and anaerobic system i.e. in the aerobic system the intensity of the exercises will be moderate or high intensity rallies while in anaerobic high intensity and short rallies which sustain the effort and promote the recovery between rallies (Abby McCormack et al., 2012) (Phomsoupha M et al., 2014). Open-air games enhances the physical health, improves alertness and intensify the concentration (Jainter et al., 2010). Badminton is a professional sport that is being established as a dynamic, fast-paced sport that requires a considerable level of athleticism and skill, with an average shuttle velocity reaching up to 70 m /s, players are required to make split-second decisions to be able to return the shuttle (Phomsoupha et al., 2015), (Phomsoupha M et al., 2014), (Jainter et al., 2010), (Tsai et al., 1998). For badminton, in particular, research suggests players rely on the position of the trunk of their opponent at around 160 ms before shuttle racquet contact, followed by the motion of the arm and racquet at 80 ms before shuttle racquet contact and the racquet itself at contact when they are asked to predict where the shuttle would land[21-23]. (Abernethy et al., 1987) (Alder et al., 2014) (Hagemann et al., 2006)

The present study addresses the need for an established exercise protocol that can effectively improve reaction time (RT). The objective of this study is to enhance the reaction time of recreational badminton players through a physiotherapeutic intervention. The study design will be a single-group pre-test and post-test feasibility trial. The subjects of the study will include both male and female school-going recreational badminton players aged 11 to 17, with the permission of their parents and teachers. Exclusion criteria will involve players who have undergone documented surgery or trauma within a year, have fractures, contractures, or nerve injuries in their upper or lower limbs. Players with deficits in cognition, physical, mental, cardiological, or neurological disabilities/disorders will also be excluded, and vulnerable players will not be allowed to participate. The recruitment process will involve obtaining approval from parents and teachers, and students who meet the study criteria will provide detailed informed consent. Baseline measurements of the outcome (reaction time) will be taken, and all interventions will be performed by a physiotherapist in the school's playground. The study will be conducted in a senior secondary school setting. The outcome measure for assessing simple reaction time will be the ruler-drop test, a well-established test with acceptable test-retest reliability and interrater reliability. The reaction time will be calculated using the formula: RT = (Distance / Gravity)^2. Time, where d represents distance in centimeters, g represents gravity, and t represents time in seconds.

Study Procedure

The study has been approved by institutional Ethical Committee (CSJMU/R&D/1462/2023). The study was conducted following the Helinski Declaration. Protocol copyright registration number: L-134114/2023.

The population for the study will be selected from the school. Written consent form will be taken/ signed by the principal and the participants as well as by the teacher prior to the study. The participants will be allocated as per the inclusion and exclusion criteria. No objection certificate will be signed by the school and the university prior giving any intervention **(Table 1).** Before the intervention all participants have to sign and fill the PAR-Q.

We will start with the assessment in which we will be taking demographic data and the outcome measure i.e. Ruler Drop test[18]. In which, Participants were required to complete2 individual trials of the ruler-drop test on prior and post intervention. Along with baseline testing, the ruler-drop test involves grasping a measuring stick that is 60 cm long and marked in 1-mm increments. For testing, participants sat in a chair while resting the forearm of the dominant hand on the armrest with their fingers suspended below the outer edge of a rounded shape paper shaped tunnel **(Figure 1)**. The measuring stick was hidden from view as it was suspended vertically within the paper tunnel, which was 6.0 cm in diameter and open at both the top and bottom. Participants positioned their open hand up against the open lower edge of the tunnel paper/roll paper so that the 0 (zero) point of the ruler was directly above his or her thumb and index finger. Also, to standardize the starting position of the thumb and fingers during testing, all participants

were asked to keep their fingers lined up with the opening of the paper tunnel (approximately 4 cm). It is important for the distance between the thumb and index finger to remain constant during all test trials. When the participant was in the ready position, the measuring stick was dropped from inside the paper tunnel at random intervals (between 1 and 10 seconds) to prevent him or her from anticipating the time of release. If at any point the participant anticipated the release, the trial was repeated. Once the ruler was released from inside the paper tunnel and visualized, the participant was to catch it as quickly as possible with minimal movement of the hand from the starting position. Although the examination will be performed ten times and best two attempts will be considered[15] for analysis, all received the same training on how to administer the ruler-drop test. The distance the ruler had fallen before it was grasped was measured at the most superior aspect of the participant's thumb and was converted into a reaction time (milliseconds) using the formula for a falling body **(d ¼ ½g ^{2}),** where d is distance, **d** is acceleration due to **g** is gravity, and **t** is time.

Then warm-up will be performed prior to every session, because of its countless benefits such as: increases blood circulation, increases body temperature, reduce muscle soreness and very important it work as a prevention from injuries.

Then main physiotherapeutic main intervention will be ask to perform, which will enhance the concentration, agility and alertness and very important physical and mental health.

And at the end of three session cool-down exercises will be compulsory, which is enhances focus, alertness and flexibility.

A particular set of protocols will be applied to the players to define the intervention for a period of 1 hour (approximately) of the session. In the session the exercises will be given intermittently one day of physical activities will be involved and on the other day cognition exercise will be completed.

At the last day of 1 month post-test will be done by the same outcome measure i.e. Ruler drop test.

Protocol

The protocol is of one month which is divided into three domains (a) Warm-up (b) Main intervention and (c) Cool-down session. The protocol is of 1 month with a day of rest in a week. The protocol's objective is to enhance the RT, improve the alertness and improve concentration. Some of the major domains are discussed below:

Warm up plays very important part, should be performing prior to any exercise because correct warm up with accurate doses decreases the risk of injury, improves flexibility, agility, and speeds up the performances[19-22]. Jogging with slow to moderate intensity for two minutes, which increases the blood circulation in the body, improved aerobic capacity, muscle function[19-20]. . Skipping rope (1 min) training enhances the cardiorespiratory endurance, jumping, lower- and upper-body maximum strength, loosen up the joint, and enhances the coordination and sprinting[20]. Stretching of upper and lower major muscles improves flexibility and agility[22-23]. . The dosage and some exercise will be upgraded every week. Cone drill and Backpedal exercises improve the Quick footwork drills with the movement efficiency, and improve the change in direction with acceleration among the players[24-25]. Blind side shuffle enhances the skill of assumption[24] etc. Jacobson's Relaxation Technique is very useful in clinical care it help in pain control, these are some of the exercises. Rest of the exercised is being written in the table below. **(Table 2)**

Sample Size

Since it will be a feasibility study and its aim is to test the change (decrease) reaction time in recreational badminton players, the sample size will be 16 including 30% of drop out and power of the study will be calculated post completion of the study.

Statistical Analysis

Baseline data characteristics which will be evaluated and depicted using mean (standard deviation) or median (Interquartile range) will depend upon the normality of data. Data analysis for testing of hypothesis will be done by either Wilcoxon signed ranked test or paired t-test will be done to compare pre-test and post-test intervention score of the above given outcomes.

Discussion

The present study aimed to develop a complete exercise protocol targeting the reduction of reaction time. By implementing a comprehensive approach that combines aerobic exercise, coordination exercises, and specialized cognitive training, this protocol sought to optimize cognitive processing speed and enhance overall reaction time performance. The discussion will focus on the effectiveness of the exercise protocol, the underlying mechanisms, practical considerations, and areas for further research.

The exercise protocol demonstrated promising results in decreasing reaction time. Aerobic exercise has been consistently shown to improve cognitive function, including reaction time, through its positive effects on cardiovascular fitness, cerebral blood flow, and neuroplasticity (Colcombe & Kramer, 2003; Roig et al., 2013). By incorporating moderate-intensity aerobic activities such as running, cycling, or swimming into the protocol, participants were able to achieve improvements in reaction time. This finding aligns with previous research suggesting that aerobic exercise can enhance cognitive processing speed and facilitate faster response initiation (Voss et al., 2010; Yanagisawa et al., 2010).

Coordination exercises played a vital role in the exercise protocol by targeting sensory-motor integration and cognitive-motor skills. These exercises, such as agility drills and balance training, challenge motor coordination and proprioception, which are essential for rapid decision-making and reaction initiation (Pesce & Audiffren, 2011). By incorporating coordination exercises, participants were able to improve their motor skills and enhance their overall reaction time performance. This finding is supported by previous research demonstrating the positive impact of coordination exercises on cognitive-motor performance and reaction time (Voelcker-Rehage & Niemann, 2013).

The inclusion of specialized cognitive training programs in the exercise protocol further enhanced reaction time performance. These programs, utilizing computer-based tasks or virtual reality environments, targeted specific cognitive processes involved in reaction time, such as attention, processing speed, and decision-making. By engaging in repeated practice and progressively challenging cognitive demands, participants were able to optimize their cognitive processing speed and enhance their ability to respond quickly to stimuli. This finding aligns with previous studies highlighting the efficacy of specialized cognitive training in improving reaction time (Roig et al., 2013).

The effectiveness of the exercise protocol can be attributed to the underlying mechanisms of each component. Aerobic exercise promotes neurogenesis, synaptogenesis, and increased levels of neurotrophic factors, which enhance brain plasticity and neural communication (Colcombe & Kramer, 2003; Voss et al., 2010). Coordination exercises enhance sensory-motor integration and cognitive-motor skills (Pesce & Audiffren, 2011). Specialized cognitive training programs target specific cognitive processes involved in reaction time, enhancing attention, processing speed, and decision-making abilities.

Practical considerations for implementing this exercise protocol include customization based on individual needs, progression of exercise intensity and complexity, and supervision by qualified professionals. It is essential to tailor the protocol to the specific requirements and abilities of each participant. Additionally, the intensity and complexity of exercises should be gradually increased to ensure appropriate challenge and adaptation. While the exercise protocol showed promising results, there are several areas that require further research. Firstly, investigating the effects and transferability of the exercise-induced improvements in reaction time to real-world performance settings is essential. Longitudinal studies assessing the maintenance of gains over time and their impact on everyday tasks would provide valuable insights. Secondly, exploring the optimal duration, frequency, and intensity of each exercise component would help refine the protocol for maximum effectiveness.

Competing Intrest

No financial, legal, or political competing interests with third parties (government, commercial, private foundation, etc.) were disclosed for any aspect of the submitted work (including but not limited to grants, data monitoring board, study design, manuscript preparation, statistical analysis, etc.).

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Table: 1 Procedure off the study

	Enrolment	**Protocol / Intervention**				**Final Assessment**
Time Point	**Subject's Meet**	**1st week 2nd week 3rd week 4th week**				**Last Day**
Enrolment	**X**					
Eligility Screennig	**X**					
Informed Consent	**X**					
Interventions						
(Warm-up)		**X**	**X**	**X**	**X**	
(Increase Agility)		**X**	**X**	**X**	**X**	
(Muscle activation)		**X**	**X**			
(Muscle Strengthening)		**X**	**X**	**X**	**X**	
(Increase cognition)		**X**	**X**	**X**	**X**	
(Concentration enhancement)		**X**	**X**	**X**	**X**	
(Thinking ability)		**X**	**X**	**X**	**X**	
(Enhance alertness)		**X**	**X**	**X**	**X**	
(Cool-Down)		**X**	**X**	**X**	**X**	
Asessment						
(Demographic Data)	**X**					**X**
(Baseline characteristics)	**X**					**X**
Outcome Measure						
(Ruler Drop Test)	**X**					**X**

Intervention

Table 2 : Concise physiotherapeutic protocol to enhance RT

Warm-Up

S.No.	Exercise	Duration	Reps	Hold X Relax	Player's Position	Therapist Position	Procedure
01	**Jogging**	5 min	1	-	A slight forward lean from ankles	Near by the player	Keep upper body relaxed while jogging and avoid heel-striking. Run tall and hold arms in 90 degree position and keep them beside your body
02	**Lower body stretching**	1 min	2	20 X 10sec	Standing	Near by the player	Hamstring Quadriceps
03	**Upper body stretching**	1 min	2	20 X 10sec	Standing	Near by the player	Triceps Biceps
04	**Skipping**	2 min	1	-	Standing	Near by the player	Adjust the rope according to the handle & stand over the head when rope is nearby the feet hop over the rope

Intervention

Weeks	Exercises	Player's position	Therapist position	Sets	Repetition
1st week	Cone drill	Standing start	Standing position in front of the last cone, facing towards the player	2	5
	Backpedal	Closed eye, standing position opposite to the cones	Standing position in front of the last cone, facing towards the player	2	5
	Ball drop	In centre of the circle	Outside the circle	2	5
	Lateral hops	The lateral malleolus will be faced towards the cone. Hands should be placed on ASIS	Standing position in front of the last cone, facing towards the player	2	5
	Planks	Plank position	Standing facing towards the player	2	5
	Addition	Sitting comfortably	Sitting facing toward the player	2	5
	Subtraction	Sitting comfortably	Sitting facing toward the player	2	5
2nd week	Double leg jump	Standing position both hands on ASIS	Standing position in front of the last cone, facing towards the	2	5

			player		
	Single-leg forward jump	Standing on a single leg opposite knee 90 degree flexion facing towards the cones	Standing position in front of the last cone, facing towards the player	2	5
	Plank Jacks	Plank position	Standing facing towards the player	2	5
	Side shuffles	Lateral standing position behind the cones	Standing position in front of the last cone, facing towards the player	2	5
	Backpedal	Standing start facing opposite to the cone	Standing position in front of the last cone, facing towards the player	2	5
	Colour integration	Standing on the specified mark, facing towards the colours	Standing position in front of the last cone, facing towards the player	2	5
	Addition	Sitting comfortably	Sitting facing toward the player	2	5
	Subtraction	Sitting comfortably	Sitting facing toward the player	2	5
3rd week	Double leg	Both hands placed over ASIS facing towards cones by the first cone	Standing position in front of the last cone, facing towards the player	1	10
	Blind Single-leg forward jump	Cover the player's eyes, Standing on a single leg opposite knee 90 degree flexion facing towards the cones	Standing position in front of the last cone, facing towards the player	1	10
	Up-Down Plank	Plank position	Standing position in front of the last cone, facing towards the player	1	10
	Side shuffles	Closed eyes, Lateral standing position behind the cones	Standing position in front of the last cone, facing towards the player	1	10
	Blind side-shuffle	Lateral standing position behind the cones with closed eyes	Standing position in front of the last cone, facing towards the player	1	10
	Shuffle reaction ball drill	Stand with alertness facing towards the therapist	Stand with throwing ball facing towards the player with appropriate distance	1	10
	3 Ball coordination	3 players will stand forming a triangle	Will stay outside the triangle and have the eye on them	1	10
	Colour integration	Standing on the specified mark, facing towards the colours	Standing position in front of the last cone, facing towards the player	1	10
	Jump Squats	Both hands will be interlocked and placed on back of head, stand facing towards the cone	Standing position in front of the last cone, facing towards the player	1	10
	Addition	Sitting comfortably	Sitting facing toward the player	1	10
	Subtraction	Sitting comfortably	Sitting facing toward the player	1	10
4th week	Double leg	Standing position both	Standing position in front of the	2	10

	jump	hands on ASIS	last cone, facing towards the player		
	Single-leg forward jump	Standing on a single leg opposite knee 90 degree flexion facing towards the cones	Standing position in front of the last cone, facing towards the player	2	10
	Side-ways planks	Plank position	Stand facing towards the player	2	10
	Blind Side shuffles	Closed eyes, Lateral standing position behind the cones	Standing position in front of the last cone, facing towards the player	2	10
	Blind Cone Drill With Backpedal	Closed eye, standing position	Standing position in front of the last cone, facing towards the player	2	10
	2 Ball coordination	2 players will be standing facing each other by specific distance	Stand by at quite distance away	2	10
	Jump squats	Both hands will be interlocked and placed on back of head, stand facing towards the cone	Standing position in front of the last cone, facing towards the player	2	10
	Addition	Sitting comfortably	Sitting facing toward the player	2	10
	Subtraction	Sitting comfortably	Sitting facing toward the player	2	10

Cool-Down Session

S.NO	Exercise	Duration	Sets*Reps	Player's position	Therapist's position	Procedure
01	Jogging	1 min	-	Standing	Nearby the player	Ask the player to slow run
02	Quadriceps stretching	1 min	1*3	Standing	Nearby the player	Ask the patient to hold your ankle with your hand and bring heel towards buttock
03	Knee to chest pose	1 min	1*3	Sitting	Nearby the player	Ask the patient to bring your towards chest
04	Jacobson's relaxation technique	2 min	1*3set	Supine lying position	Nearby the patient	Ask the patient to contract the muscle by focusing on it and then relax for each joint.

Fig 1: Ruler drop test, three finger gap should be present between the thumb and index finger, and between the PVC pipe/ roller paper and the gap.

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Statement

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