Original Article

Impact of Comprehensive Exercise Training on Reaction Time in Female Recreational Badminton Players: A Pilot Study

Anjali Raghuwanshi, Digvijay Sharma, Apoorva Srivastava, Adarsh Kumar Srivastav.

Abstract

Background:

Reaction Time [RT] crucially maintains and governs activities of daily living. It is a critical measure of how quickly an individual can respond to a stimulus, reflecting the efficiency of cognitive and motor processes. Especially required in sports like badminton, RT can have a significant difference in the performances of athletes.

Aim:

To investigate the effectiveness of a tailored yet comprehensive exercise regimen designed to decrease RT.

Materials and Methods:

This pilot study utilized a quasi-experimental design, which evaluated 16 participants through a four-week comprehensive exercise training's effects on RT reduction in female recreational badminton players aged between 11-17 years. Females who had suffered any injury within 12 months, older/ younger than above age group, had undergone badminton training or had documented cognitive deficit were excluded from the study. The intervention obeyed the Frequency Intensity Time and Type [FITT] principle. Ruler drop test was assessed by an assessor that was blinded.

Results:

Since, the scale used as an outcome was an interval scale, parametric test was performed. For within-variable analysis, Paired-t test was used and Pearson's correlation coefficient to evaluate the correlation between the variables. The post-intervention results revealed a significant difference within RT from [10.27+0.25] seconds to [1.07+0.22secomds] [$p<0.001$].

Conclusion:

The integration of appropriate training programs at school level is capable of providing significant benefits within athletic excellence, cognitive functions, thus contributing to holistic development in young athletes.

JK-Practitioner2026(31(1):56-59

Introduction

Reaction Time [RT] is pivotal in every individual's life.[1] It is a critical measure of how quickly an individual can respond to a stimulus, reflecting the efficiency of cognitive and motor processes.[2] It includes some stages, including sensory detection, neural processing, decision-making, and motor execution, making RT a key indicator of neurological function and performance.[3] Variability in RT can be influenced by factors such as age, fatigue, alcohol consumption, and the nature of the stimulus. In life applications, RT is vital in factors ranging from sports performance to driving safety, where swift responses can prevent accidents and enhance competitive edge.[4] RT provides insights into cognitive processing speed and decision-making capabilities, making it an essential focus in sports and academic performances.[5]

RT is a crucial determinant of athletic performance, significantly impacting an athlete's ability to respond quickly and efficiently to dynamic situations in competitive sports.[6] It represents the interval between receiving a stimulus. In high-stakes games, even fractions of a second can make a difference between victory and defeat. For instance, in sports like sprinting, basketball, tennis, and badminton, athletes with superior RT can anticipate their performance, evade opponents, and execute strategies more effectively, thereby enhancing their overall performance.[7] Studies indicate that elite athletes often exhibit markedly shorter RTs compared to recreational players, allowing them to make quicker decisions under pressure and adapt to rapidly changing game scenarios. Furthermore, training focused on improving RT not only sharpens their physical responses but also enhances cognitive functions like decision-making and situational awareness.[8] Thus, improving RT is an essential factor for athletes seeking to maximize their competitive edge and achieve peak performance in their respective sports.[9]

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Indexed

EMBASE, SCOPUS, IndMED , ESBCO, Google Scholar besides other national and international databases.

Cite this article as

Raghuwanshi A, Sharma D, Srivastava A, Srivastav AK. Impact of Comprehensive Exercise Training on Reaction Time in Female Recreational Badminton Players: A Pilot Study
JK Pract2026;31(1):56-59

Full length article available at **jkpractitioner.com** one month after publication

Keywords

Athlete, Cognition, Executive Functions, Females, Reaction Time.

Current literature reveals a gap in established exercise-based protocols that effectively reduce RT while also aid in enhancing academic performance.[10] By addressing both physical and cognitive aspects of performance, this research seeks to provide a holistic approach to improving the RT in athletes and students alike.[11] The study aimed to investigate the effectiveness of a tailored exercise regimen designed to decrease RT. The objective was to evaluate the effectiveness of this developed comprehensive exercise protocol that incorporates activities aimed at enhancing agility, coordination, and overall fitness, thereby stimulating both physical and cognitive abilities over RT of individuals. Thus, we hypothesize that there will be no significant differences in RT before and after administration of comprehensive exercise protocol.

Material and methods

This pilot study utilized a quasi-experimental design to assess the effect of a four-week comprehensive exercise intervention on RT reduction in recreational players [RP]. The research took place in a secondary school setting. Since the sample population was minor [below 18 years of age], written informed consent was obtained from the school authorities, and guardians of athletes. A sample size of 16 participants was followed with a 30% dropout rate, which is a commonly accepted parameter in pilot studies.[12] The inclusion criteria was carefully designed to ensure participant's homogeneity, it includes individuals aged between 11-17 years old, recreational badminton players [often play minimum three days in a week] females, and participants who must not have any training or professional experience in badminton. Conversely, the exclusion criteria encompassed individuals outside the specified range, those with prior training or professional badminton players, those who have undergone surgery or experienced trauma within the past year, individuals with cognitive deficits, vulnerable recreational players, and those who have been on any documented medication from past six months. To minimize biases, assessors were blinded to the intervention. Screening of participants was done strictly according to the selection criteria. After the recruitment of participants, their demographic details and pre-test outcome measures using the Ruler Drop test, which shows good reliability [ICC = 0.81] [13], was obtained. Intervention was developed under three criteria i.e., warm up, from week one to fourth intensity and frequency were changed based on the FITT principle [Frequency, Intensity, Time, and Type], and in the third stage cool-down sessions were performed. Post-outcome measures were obtained after the participants completed a duration of four weeks.

Protocol

A thorough exercise protocol was formulated for the recreational players to enhance their flexibility, physical fitness, agility, hand-eye coordination, cognition, and lung capacity and to reduce their reaction time in four weeks. The protocol is based on the FITT principle [Frequency Intensity Time and Type]. Every week the intensity and frequency of the exercise changes. Because in a certain period, the body adapts to a daily routine. The protocol is divided into three groups, active warm-up, intervention, and cool-down exercises.[3]

Warm-Up: Warm-ups have multiple benefits including increased blood flow, improved muscle flexibility, enhanced joint mobility, activation of the nervous system, mental preparation, injury prevention, enhanced motor skills, and enhanced performance.[13]

Intervention: Intervention is mainly based on reducing the RT, enhancing flexibility, and coordination, reducing excursion, and mainly aerobic exercises to improve and cool down session which also includes Jacobson's technique.[13]

Cool-Down: It plays a crucial role in sports training. It is prescribed for the relaxation of the body gradually. It normalizes the heart rate and slows breathing and relaxation. Hence, prevents life-threatening conditions. In cool-down jogging, stretching of the quadriceps and hamstring will be performed with 30 30-second holds. These exercises help in cooling the body temperature as well. Knee-to-chest pose and Jacobson's technique will also be performed after the intervention, in the form of a cool-down exercise. [Figure 1]

Intervention

Broadly intervention is divided into four main categories flexibility, alertness, balance, and coordination. Each week frequency or intensity is been changed.

First week exercises

During the first week, exercises include the Cone Drill, Backpedal, Ball Drop, Lateral Hops, Planks, Addition, and Subtraction. For the cone drill, players start from a standing position, facing the therapist, who stands in front of the last cone. Each exercise is done in two sets of five repetitions. The Backpedal exercise involves the player standing with closed eyes, facing opposite the cones, with the therapist positioned similarly as in the Cone Drill. The Ball Drop requires two participants to stand in the center of the circle, with the therapist outside monitoring the activity for four minutes.

Lateral Hops have the player's lateral malleolus facing the cone, with hands-on ASIS [anterior superior iliac spine], performed in two sets of five repetitions. The Addition and Subtraction exercises are done sitting comfortably, with the therapist facing the player, in two sets of five repetitions each.

Second week exercises

In the second week, exercises progress to include the Double Leg Jump, Single-Leg Forward Jump, Plank jack, Side Shuffles, Backpedal, 2 Ball Coordination, Color Integration, Addition, and Subtraction. Each exercise follows a format of two sets of five repetitions, except for the ball coordination and color integration exercises, which are timed.

The Double Leg Jump requires the player to stand with both hands on ASIS, while the therapist stands in front of the last cone. For the single-leg Forward Jump, the player stands on one leg with the opposite knee at 90

degrees, again facing the cones. Plank Jacks are performed in a plank position, with the therapist observing from the front. Side shuffles and Backpedal exercises involve lateral movements and are performed with the therapist in the same monitoring position as before. The 2 Ball Coordination involves three players forming a triangle, with the therapist outside the triangle. Color Integration requires the player to stand on a marked spot [center of the semi-circle], facing toward the colors on the ground, under the therapist's watchful eye.

Third week exercises

The third week includes more challenging exercises such as the Double Leg Jump, Blind Single-Leg Forward Jump, Up-Down Plank, Side Shuffles, Blind Side-Shuffle, Three-Ball Coordination, Color Integration, Jump Squats, Addition, and Subtraction. These are generally done in one set of ten repetitions each. The Blind Single-Leg Forward Jump involves covering the player's eyes, adding a balance challenge. Up-down planks and Side Shuffles continue the emphasis on the core stability and lateral movement.

Blind Side-Shuffles and three-ball coordination increased the difficulty with visual and coordination elements. Color Integration, Jump Squats, Addition, and Subtraction exercises continue to build on cognitive and physical integration skills.

Fourth week exercises

In the fourth week, the routine includes Single-Leg Forward Jump, Side-Ways Plank, Blind Shuffles, Blind Cone Drill with Backpedal, Modified two-ball coordination, addition and subtraction. These exercises are performed in two sets of ten repetitions each.

Double-leg Jump focuses on explosive strength and balance, respectively. Side-Ways Planks and Blind Side Shuffles challenge the core and balance further. The blind cone drill with backpedal combines agility and spatial awareness. Modified 2-ball coordination involves two players facing each other, emphasizing reaction and coordination.

Cool-down exercises

The cool-down routine consists of Jogging, Quadriceps and Hamstring Stretching, Knee Chest Pose, and Jacobson's Relaxation Technique. Each exercise is performed for one to two minutes, helping the player gradually transition from high-intensity activities to a resting state. Jogging helps to slow the heart rate, followed by stretching exercises to maintain flexibility. The knee-to-chest pose, done while sitting, aids in lower back and hip flexibility. Jacobson's Relaxation technique, performed in the supine position, helps relax each muscle group, providing a comprehensive cool-down.

Statistical Analysis

The data was collected and analyzed using the IBM Statistical Package of Social Sciences i.e., SPSS statistics 29.0 version. p-value <0.05 was considered significant. Since, the scale used as an outcome was an interval scale, parametric test was performed. For within-variable analysis, Paired-t test was used and Pearson's correlation coefficient was used to evaluate the correlation between the variables. Data for demographic detail is represented in Mean [95% Confidence Interval]. Correlation was also calculated using Pearson's Correlation Coefficient was evaluated for relationship between pre-and post-values of variables which were depicted using Scatter plots.

Results

Additionally, Shapiro Wilk test was used to assess the normality of the data. The baseline characteristics were analyzed, yielding p-values for various parameters: age [13.64+1.20; p=0.389], height [1.56+0.05m; p=0.163], weight [48.8+ 5.95kg; p=0.405], and the body mass index [BMI] [19.9+2.10; p=0.024]. The post-intervention results revealed a significant difference was observed in RT, with mean RT decreasing from 10.27+0.25secomds to 1.07+0.22secomds [p<0.001] Tale 6. A significant difference was observed in each individual as shown in figure 1

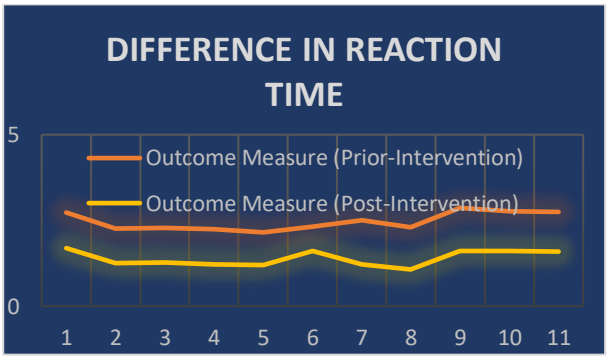

Figure 1 Training impact and reaction time in recreational players.

Discussion

Executive function [EF] has a significant impact on the major cognitive domains required for better functioning and performance upliftment, especially in athletes, which may include the decision-making capacity of athletes, attentiveness, and the power of problem-solving methodologies to be adapted during the game or session.[14] Badminton is an open-skill sport that demands split-second decisions, RT is one of the major components of EF which measures how quickly a person can respond to a stimulus, is a vital success.[15,16] Enhanced RT allows players to make fast strategic moves, eventually improving both performance and providing a competitive edge,[17,9,18].

Training at the school level, even for recreational players, is very important as it not only builds foundational skills but also helps to reduce the risk of injuries in the future. Early exposure to proper techniques and conditioning prepares young RP physically and mentally. Early training will also make their journey easy if they choose to pursue sports professionally. Additionally, the present study has found that structured training contributes positively to academic performance, as students develop focus, discipline, and resilience. Teachers noted improved

engagement and participation in the classroom, with some students initiating involvement in school events, suggesting multiple benefits from their sports training.

The result of the present study indicates a measurable improvement, including in RT and overall performance in badminton skills among participants. Especially, two of the participants involved in the study later qualified for the junior national competitions. This outcome highlights the potential of structured, school-level training to positively impact young athlete's performance and open pathways to competitive opportunities. Significant improvements were observed in RT and related cognitive and athletic performances by employing a comprehensive intervention based on the FITT principle. The findings highlight the dual benefits of physical training in enhancing athletic skills and academic engagement, as demonstrated by improved classroom participation and focus. However, this study has several limitations. The small sample size limits the generalizability of the findings, which makes it challenging to draw broader conclusions. Additionally, while the RDT was chosen as an assessment tool because of its feasibility, it is not a gold standard measure for RT assessment in badminton players. Future studies should consider using validated tests made to badminton-specific movements to obtain more precise and reliable results, Expanding the sample size and including a control group would also strengthen the validity of future research, potentially providing more conclusive insights into training's long-term impacts on athletic and academic development.

Conclusion

The present study underscores the importance of structured exercise protocol for reducing the RT among young RBP. Ultimately, the integration of such training programs at the school level could provide significant benefits by encouraging athletic excellence, improving cognitive functions, and opening opportunities for competitive sports, thus contributing to holistic development in young athletes.

Conflict of interest Nil.

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