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Effectiveness of a Sports-Specific Warm-Up Protocol versus a Conventional Training Program in Badminton Players: A Quasi-Experimental Study

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Abstract

Background: Badminton is a sport in which players use a combination of speed, endurance, strength and coordination over lengthy, high-intensity actions that are broken up by rest breaks. In sports, a warm-up is a pre-exercise session intended to improve performance in competition or training. Training that has been introduced into training programs involves properly warming up the body before physical exercise. To Compare the Effectiveness of Sports Specific Warm Up Protocol versus Conventional Training Programme in Badminton players.

Material and Method: The study was Quasi experimental in nature involved 30 males subjects, aged 18 to 30 years, who were playing Badminton at least thrice a week were included in the study as per the selection criteria. All subjects were enrolled in the study after taking their informed written consent and were divided into two groups through simple random sampling method Group A (n=15) and Group B (n=15). Group A received Sports Specific Warm Up Protocol (SSWP) and Group B received Conventional Training Programme (CTP). The subjects were assessed for agility, vertical height and speed using Agility t test, Vertical jump height and General speed test. The intervention consisted of 4 sessions per week over duration of 6 weeks. The subjects were reassessed at the end of the intervention that is after 6th week.

Result: Statistical analysis revealed significant improvement within both group. However, between group comparison demonstrated that group A exhibited statistically significant improvement ($p< 0.001$) than Group B across all outcome measures, including agility test, vertical jump test, and general speed test.

Conclusion: The present study concluded that a Sports-Specific Warm-Up Protocol is more effective than a Conventional Training Programme in improving vertical jump, speed, and agility in badminton players.

Keywords: Agility, Badminton, Speed, Vertical Height, Warm Up

Introduction

The most popular racket sport in the world is badminton where two players (in singles) or four players (in doubles) stand on opposite rectangular courts and attempt to score a point by hitting a shuttlecock over a dividing net. A rectangular indoor or outdoor court is used for badminton, a recreational and competitive sport. People across all age groups can sustain their physical fitness by playing badminton. The number of women participating in sports has increased significantly during the past 30 years [1]. Badminton, demands quick reflexes due to the fast-paced ball and small, constrained space. A reaction time is the duration required reacting to an abrupt input [2]. In badminton, the goal is to hit the shuttlecock over the net and into the opponent's playing area, much like on a tennis court. Both men and women as well as groups of children and adults can participate in this sport. Footwork plays a significant role in badminton technique. Good footwork allows players to move smoothly and swiftly across all areas of the court, enabling them to maintain an optimal position and respond effectively to their opponent's strokes. The fundamental technique in badminton involves mastering essential skills that every player needs to play effectively. Players must learn and practice key strokes, including Drive, Netting, Smash, Drop shot, Underhand, Service [3]. A badminton court is made up of two parts, each of which is 6.7 meters long and 6.1 meters wide [4].

In badminton, players position themselves diagonally opposite to the service courts to start a singles match [5]. In badminton, a shuttlecock's initial speed after a smash is faster than comparable motions in other sports. As seen by the fastest speeds ever

recorded for singles and doubles matches in major badminton tournaments— 417 and 426 km/h [7]. With match lengths ranging from 40 minutes to an hour [6].

During a match, players are frequently required to sprint, stop abruptly, accelerate, jump, stretch, pivot and take wide steps, all while maintaining balance and control. These actions are repeated continuously, placing significant physical strain on the body. Over time, this can lead to fatigue, which negatively affects cardiovascular and respiratory function, muscular performance and joint stability [7]. Badminton involves both aerobic and anaerobic energy expenditures [8]. During match play, heart rates have been shown to reach up to 100% of an athlete's maximum with an average of 169 beats per minute. Blood lactate levels during competition typically range between 3 and 6 mmol/L, indicating a significant anaerobic contribution [9]. Among the physical attributes required, agility and speed play a vital role. Agility refers to the ability to change direction quickly and efficiently, a necessity in badminton due to the fast-paced nature of the game. On the other hand, speed is the capacity to cover a certain distance in the shortest time possible. Both agility and speed are crucial for a player's success, as they enable rapid responses to an opponent's shots and enhance the player's ability to maintain control during rallies [10].

For optimal performance and injury avoidance, players need high levels of dynamic balance and agility. Balance is essential for managing shifts in the center of gravity, especially during actions like jump smashes and rapid offensive or defensive transitions [9]. During the 1992 Summer Olympics in Barcelona, badminton was added to the Olympic program and has since continued to be a part of the Games [12]. Since its inclusion as an official Olympic sport at the 1992 Barcelona Games, badminton has seen a significant rise in popularity [13]. After its 1996 debut, badminton has drawn over a billion spectators, making it the most watched sport at the Olympics [14]. Indian athletes now hold the top spot in the Badminton World Federation (BWF) rating for both men's and women's singles and they have more players than any other nation in the top thirty rankings for men's singles [15]. In addition to being an Olympic sport, 200 million people play badminton as a recreational activity outdoors, frequently as a beach or garden game [11].

In sports, the term warm-up (WU) refers to a period of preparation prior to physical activity, typically before high-intensity training or competition. The primary objective of warming up is to optimize performance and minimize injury risk by gradually preparing the body for more strenuous physical demands. A proper warm-up increases heart rate, blood circulation, muscle temperature and body temperature which collectively improve blood flow to the muscles and speed up nerve signal transmission. These physiological responses also help reduce muscle viscosity, allowing for smoother muscle activation and faster neuromuscular response [8]. Types of Warm-Ups: Warm-ups are generally categorized into two types: general warm-ups and specific warm-ups [16].

Conventional (or traditional) exercise programs are commonly believed to involve exercises targeting specific muscles or muscle groups to effectively increase strength. In badminton, coaches and players use a variety of traditional training methods to enhance both physical fitness and sport specific performance. These methods include, Technical training, Psychological skills training, Strength training, Speed and power training, Flexibility training, Aerobic training [17].

Methods

Research design, settings, and the ethics

The study was quasi experimental in nature. The study was conducted at Barjindra college, Faridkot and nearby places in the periods between April 2024 and March 2025. The study was approved by institutional ethical committee of Baba Farid University of Health sciences, Faridkot (BFUHS/2K25p-TH/885). Prior to the commencement of the study, the subject were informed about study and informed consent was obtained from them.

Participants

The study included male subjects aged between 18 to 25 years who were active badminton players with more than one year of continuous playing experience. Participants were required to be regularly involved in badminton, playing at least three times per week. Additionally, only those subjects who were willing to complete the full 6-week intervention program were included in the study.

Subjects were excluded if they had sustained any recent injuries or were currently in their off-season. Players who regularly participated in sports other than badminton were also excluded to maintain specificity. Furthermore, individuals with a history of lower extremity injuries such as ACL, hamstring, meniscus, ankle, or any other condition affecting dynamic balance within the past three years were excluded from the study.

Study procedure

Subjects were divided into two groups through simple random sampling method (Group A and Group B). The subject was assessed for Agility, Vertical height, and speed using Agility t-test [20, 21], Vertical jump height [21, 22], General speed test [23]. Group A (n=15) were receive Specific Warm Up Protocol and Group B (n=15) were receive Conventional Training Programme 4 times per week. Subjects were assessed at 0thday and reassessed at the end of the intervention that was after 6 week. [Fig 1].

Interventions

Sports specific warm –up protocol [6]: Subjects in this group were instructed to perform sports specific warm up protocol 4 times weekly for 6 weeks. As given in Table 1.

Conventional training programme [17]

Conventional training programme involved warm up jogging, backward jogging for 10 mint [24], Flexibility Training, (Arm curls, Frontal leg swings (both leg) 10 reps per leg, Lateral leg swings (both legs) 10 reps per leg, Dynamic arm swings forward and backward 10 reps) [25], Endurance training, (Skipping × 100reps) [24], Fast feet running × 10 reps) [25], speed training, (Corner shadow movements 2×2 round, Bilateral countermovement jumps 5reps) [25], Specific Strength Training (Push-ups -2set ×5reps, Climbing steps) [25], Technique and Tactic Training, (Front, middle and back strokes made in court 30 secs loads, a total exercises of 12 sets, 10 seconds rest period between each set for 15 mint) [26], Coordinative Ability Training (Multi-shuttle, Forward and backward court stepping training (5 sets of 20 secs, 1 mint rest and total time 15 mint) [26], Mental Training, Practice Match, Recreational

Games and Warm Down (Walk brisk/ jogging, Breathing and stretches 10 mint) [26].

Table 1: Description of Sports Specific Warm Up Protocol

S. No	Exercise	Description	Repetitions / Sets	Duration
1	Calf Jumps	Stand with back straight, core tight, hands by sides. Push off ground using balls of feet.	15 reps × 3 sets/session	6 weeks
2	Vertical Jumps	Jump vertically upward to enhance athletic performance.	15 reps × 3 sets/session	6 weeks
3	Marching Drill	March by placing one foot 12 inches forward, weight evenly on both feet.	15 reps × 3 sets/session	6 weeks
4	T-Run	Forward, lateral, and backward running over T-mark.	5 repetitions/session	6 weeks
5	Side Squats	Wide stance, shift weight to one side, bend knee while other leg remains straight.	15 reps × 3 sets/session	6 weeks
6	Burpees	Squat → hands on floor → jump to plank → return → jump upward.	12 reps × 2 sets/session	6 weeks
7	Side Lunges	Step sideways, bend leading knee, keep opposite leg straight.	15 reps × 3 sets/session	6 weeks
8	Inch Worm	Bend forward, walk hands forward, then return to standing.	12 reps × 3 sets/session	6 weeks
9	Walking Lunges with Trunk Twist	Perform lunge with trunk rotation towards front leg.	5 rounds/session	6 weeks
10	Multi-Directional Lunges	Perform lunges in forward, lateral, diagonal, and backward directions.	10 reps × 3 sets/session	6 weeks
11	Squat Jumps	Perform squat followed by explosive jump and controlled landing.	12 reps × 3 sets/session	6 weeks

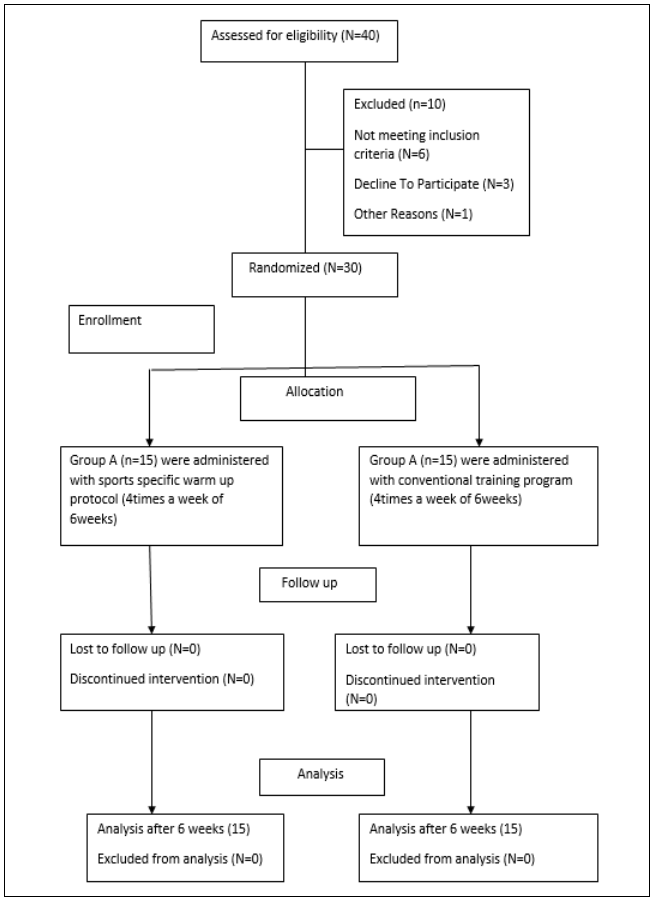

Fig 1: Consort flow diagram showing progression of subjects through the study

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics and Microsoft Excel. The level of significance was set at $p < 0.005$. Mean and standard deviation were calculated for all outcome variables (Vertical Jump Test, General Speed Test, and T-Agility Test).

Paired t-test was used for within-group comparison (pre-test vs post-test), while unpaired t-test (independent t-test) was used for between-group comparison (Group A vs Group B). Mean differences before and after intervention were analyzed to assess performance improvement.

Results

At baseline, there was no statistically significant difference between Group A and Group B in any of the assessed outcome measures, indicating that both groups were comparable before the intervention. For agility, the mean values were 13.436 ± 1.230 in Group A and 13.480 ± 1.073 in Group B ($p = 0.918$). Similarly, for general speed, the mean values were 48.33 ± 5.486 and 48.53 ± 5.263 in Group A and Group B, respectively ($p = 0.920$). For vertical jump, the mean values were 41.400 ± 2.448 in Group A and

41.815 ± 3.089 in Group B (p = 0.687). After 6 weeks of intervention, statistically significant differences were observed between the groups in all outcome measures. Group A showed better agility performance compared with Group B (11.078 ± 1.203 vs. 12.309 ± 1.173; p = 0.008). Similarly, general speed improved significantly more in Group A than in Group B (39.07 ± 2.187 vs. 42.60 ± 4.405; p = 0.010). For vertical jump, Group A demonstrated a significantly greater improvement than Group B, with post-intervention mean values of 48.802 ± 4.044 and 45.889 ± 1.034, respectively (p = 0.012). Overall, although both interventions resulted in improvements in performance variables, the sports-specific warm-up protocol demonstrated significantly greater effects on agility, general speed, and explosive power compared with the conventional training program.

Table 2: Demographic Profile of Subject in Group A and B

Demographic characteristics	Group A (Mean ± SD)	Group B (Mean ± SD)
Age (Yrs)	21.80 ±1.568	20.27±1.668
Height (cm)	170.7733± 13.35635	169.616± 4.76893
Weight (kg)	65.53± 4.240	60.60±2.384
BMI (kg/m^2)	23.040± 4.2908	21.067 ±1.2562
BMR	1622.93±94.623	1568.67± 34.179

Table 3: Comparison of Scores of Agility Test, Vertical Jump Test, And General Speed Test Between Two Groups at 0th Week and After 8th Week

Parameters	Group A			Group B		Between group		
	Pre test	Post test	Within group P value	Pre test	Post test	Within group p value	Pre test p value	Post test p value
Agility test	13.43 1.230	11.078 1.203	<0.001	13.480 1.073	12.309 1.173	<0.001	0.918	0.008
Vertical jump test	41.400 2.448	48.802 4.044	<0.001	41.815 3.089	45.889 1.034	<0.001	0.687	0.012
General speed test	48.33 5.486	39.07 2.187	<0.001	48.53 5.263	42.60 4.405	<0.001	0.920	0.010

Discusssion

Warming up is an essential pre-exercise activity that boosts performance and minimizes injury risk by gradually raising blood circulation, body temperature, heart rate, and anaerobic capacity [15]. It also lowers the chance of muscle soreness by easing the body into more intense physical effort. It also enhances range of motion and boosts anaerobic capacity. However, insufficient warm-up intensity may negatively impact performance and reduce the reliability of joint-specific range of motion [1]. Therefore the aim of study is to compare the effectiveness of sports specific warm up protocol versus conventional training program in badminton players.

The findings of present study indicate that both training interventions led to significant improvements in agility, speed and vertical jump height, but sports specific warm up protocol (Group A) demonstrated superior gains compared to Conventional Training programme (Group B). The observed improvements were consistent with previous research highlighting the effects of warm up exercises on performance of badminton players.

Improvement in agility, speed, and vertical jump height: Both groups exhibited significant improvements in agility, speed and vertical jump height but Group A (sports specific warm up protocol) demonstrated a greater reduction in completion times, indicating superior gains.

The finding of this study showed that there was significant effects on performance by improving speed, agility and vertical jump height. Warm-up can improve performance by increasing muscle temperature and reducing the risk of injury. One of the previous study has been done in 2021 by Alia, dr. aqeel ahmed khan. *et al*. analyzed the effects of warm up exercise on performance of badminton players. The findings of the current study suggest that warm-up exercises can enhance coordination, strength, flexibility, and endurance, thereby improving the overall performance of badminton players [1].

Sudesh chettri *et al*. 2022 conducted study to investigate the impact of FIFA 11+, Dynamic and Regular Warm-up Protocols on Speed, Agility, and lower limb explosive power in Badminton players" This suggests that the warm-up routine followed by the control group of badminton players was comparably effective in sustaining performance levels when compared to the FIFA 11+ program and dynamic stretching protocols [18].

The study conducted by Andrade DC *et al*. in 2015 determine the Effectiveness of general, specific and combined warm-up on explosive muscular performance. In summary, general, specific, and combined warm ups can improve slow stretch-shortening cycle (SSC) muscle performance; however, only specific warm-ups are effective in enhancing fast SSC performance. Therefore, to optimize fast SSC function, warm-up routines should include targeted fast SSC movements [16]. Warming up offers key benefits such as enhanced anaerobic performance and improved range of motion. However, insufficient warm-up effort can lead to limited or inconsistent joint mobility. To boost performance and minimize injury risk, it is essential to warm up properly, as the effectiveness of a warm up depends on its duration, intensity, and quality.

On the other hand, Traditional exercise programs are typically structured to isolate individual muscles, aiming to enhance strength more efficiently. In badminton, coaches and players often utilize components of conventional training—such as flexibility, aerobic conditioning, strength, speed, power, psychological preparation, and technical skill development—to improve physical fitness and overall performance. However, some studies did not support to this study which are following. Accordingly, to previous study which was conducted by man tong chua *et al* in 2021 [15] on effectiveness of on courts resistive warm up on change of direction. speed and smash velocity during a simulated badminton match play in well trained players. They reported that WWR and BVR warm-up routines effectively enhance change of direction speed through optimal post-activation performance enhancement (PAPE) effects, but they are less effective in improving smash velocity compared to other similar warm-up exercises [6]. There was one more another study which did not support to the result of study which is done by wing-chun V. yeung *et al*. to determine that does a loaded warm up influence jump asymmetry and badminton specific change of direction performance and they reported that No significant differences were found in change of direction speed (CODS) performance between warm-up (WU) routines and a control or conventional warm-up (CMU) among amateur badminton players [19].

The study was limited by its small sample size, restricted age group, inclusion of only male badminton players, and

conduct within a limited geographical area, which may affect the generalizability of the findings. Additionally, no long-term follow-up was performed to evaluate the sustainability of treatment effects. Future research should include larger and more diverse samples, including female athletes and players of different age and skill levels, with longer intervention and follow-up periods. Further studies should also evaluate additional outcomes such as strength, endurance, flexibility, balance, injury prevention, and compare sports-specific warm-up protocols with other warm-up strategies.

Conclusion

The present study concluded that a Sports-Specific Warm-Up Protocol (SSWP) is more effective than a Conventional Training Programme (CTP) in improving vertical jump, speed, and agility in badminton players. Significant improvements in the SSWP group suggest that sport-specific warm-ups better prepare athletes for the physical demands of badminton by enhancing neuromuscular activation and movement efficiency. These findings highlight the importance of incorporating sport-specific warm-up routines to optimize athletic performance.

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