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# COMPARISON OF SKILL-RELATED FITNESS IN FOUR SPORTS INVOLVING OVERHEAD MOTIONS IN THE UNIVERSITY OF PERADENIYA

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## ABSTRACT

Skill-related physical fitness components significantly impact equilibrium, movement precision, rapid directional shifts, force generation, and the ability to respond to stimuli. Assessing and addressing these factors are paramount for athletes and coaches, promoting success in sports involving overhead motion. The aim was to compare skill-related physical fitness among athletes playing badminton, basketball, netball, and volleyball for the university team at the University of Peradeniya. It was an observational cross-sectional study. All seventy-seven athletes (mean age 23.05±1.52) from the university team and eighty subjects were recruited as controls (mean age 24.47±1.84). Star excursion balance test, alternate hand wall toss test, Illinois agility test, overhead medicine ball throw test, nelson hand reaction time test, and Kinovea were the measures used to assess skill-related physical fitness factors. One-way ANOVA and Sheffe test were utilized, significace level was set as $p<0.05$ with 95% confidence interval. The results revealed that the basketball players exhibited better dynamic balance performance in right posteromedial (95.94±19.59) and left posterior directions 104.26±26.03 compared to badminton players. Also, volleyball players showed better dynamic balance performance in right medial direction (81.60±23.04) compared to badminton players. Results of independent sample t test showed a significant difference in balance and coordination, while there was no statistically significant difference in agility, power, reaction time, and speed between the athletes and the control group. The findings of the study emphasize the importance of formulating training programs to improve skill-related physical fitness among the University athletes playing badminton, basketball, volleyball and netball. This is essential to improve their performance and to prevent injuries that can occur due to inadequate skill-related physical fitness..

***Keywords:*** *Skill-related physical fitness, training parameters, overhead throwing athletes*

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## 1.0 INTRODUCTION

Throwing is a complicated motion in which energy is transferred from the lower to the upper extremities and finally to an object in order to move it away from the thrower. Overhead throwing and overhead motion are a major part of many sports, such as volleyball, cricket, netball, basketball, baseball, and badminton as well as many others. Proper mechanics is involved in distributing energy throughout the kinetic chain, beginning with the push-off of the lower extremities, progressing through the rotation of the pelvis and torso, elbow extension, and shoulder rotation. Overhead throwing carried the maximum amount of kinetic energy from one phase to another to throw the ball with maximum potential.(Kibler, Wilkes, & Sciascia, 2013)

Physical fitness is essential to increase the individual's maximum physical capacity and performance. Health-related physical fitness and skill-related physical fitness are the two major categories of physical fitness. But skill-related physical fitness components play a major role in improving sports performance abilities when compared to health-related physical fitness components. It comprises six components: balance, coordination, agility, speed, power, and reaction time. (DeMet & Wahl-Alexander, 2019)

Games involving overhead motion have become popular in Sri Lanka, and common injuries are associated with these games. Risk of injuries can be reduced by improving skill-related physical fitness among these athletes. (Smita Wagh, Yatin Wagh, & Kamini D Nikam, 2022) Furthermore, they need specific-fitness training tailored to the demands of their respective sports. For example, volleyball players needed to focus on speed, power, and agility, while netball players require good agility, speed, and power to excel in their sport. Badminton players should focus on speed and agility, while basketball players needed power, speed, balance, and agility to enhance their sports performance. Based on the evidence, specific sports require specific skill-related fitness training. This training should target enhancing the skill-related physical fitness factors important for better performance and injury prevention among athletes. (Briner & Kacmar, 1997) There are many sports available at the University of Peradeniya that involved overhead motion. Among these, netball, volleyball, basketball, and badminton had similar overhead throwing mechanisms.

Sports involving overhead motion have become popular in Sri Lanka and there are common injuries related to these games. Literature and findings from other studies suggest that skill-related physical fitness factors are essential to improve performance and prevent injuries among athletes. An athlete requires adequate physical fitness factors: speed, power, agility, balance, reaction time and coordination to improve sports performance. Further, they need specific- fitness training which varies from sport to sport. For example, volleyball players need to target on speed, power, and agility whereas, netball players need good agility, speed, and power to improve sports performance. Badminton players should have speed and agility. Basketball players need power, speed, balance, and agility to improve their sports performance. Based on evidence, specific sports require specific skill-related fitness. Skill-related physical fitness will be influenced by the training programme. It is evident that the training should focus on enhancing the skill related physical fitness factors that are important for better performance and injury prevention among athletes. There are many sports available in the University of Peradeniya which involves overhead motion. Among these, netball, volleyball, basketball, and badminton have similar mechanism of overhead motion.

The present study aimed to compare skill-related physical fitness factors between badminton, basketball, volleyball, and netball players in University of Peradeniya and to compare them against a control group. The findings of this study would be helpful to identify if skill-related physical fitness is adequate among university athletes. Based on these findings, training programs for the athletes can be modified to enhance performance.

## 2.0 METHODOLOGY

This observational cross-sectional study was conducted among athletes of sports involving overhead motion, who have been a part of the University team for volleyball, badminton, netball, and basketball at least for the past six months. Athletes, who sustained an injury in the last 6 months, play more than one sport at a competitive level and players who were with external appliances/deformity were excluded from the study. There were 24 volleyball players (male-12, female-12), 25 basketball players (male-13, female-12), 12 netball players (female-12) and 16 badminton players (male-8, female-8) in the University team. Considering the small sample size, total population sampling method was used. Accordingly, All the athletes who consented to participate in the study and satisfied the inclusion criteria were recruited as sample for the study. Considering 77 players in the University team, 80 controls (males-45, females-45) were recruited for the study by open invitation through flyers by convenient sampling. This study was approved by the Ethics Review Committee of the Faculty of Allied Health Sciences, University of Peradeniya, Sri Lanka (AHS/ERC/2023/019) on 17th May 2023. The study recruited 77 athletes who gave their written informed consent and satisfied the inclusion criteria. Accordingly, 80 subjects were recruited as controls (males-40, females-40) through open invitation via flyers by convenient sampling.

Socio-demographic data, history of injury or any comorbidities, were collected. All the subjects were asked to engage in a three-minute warm-up by running and performing arm stretches. Star excursion balance test, alternate hand wall toss test, Illinois agility test, overhead medicine ball throw test, nelson hand reaction time test, and Kinovea were used to assess balance, coordination, agility, power, and reaction time and speed respectively. One investigator was assigned to each test station. In total, each athlete spent approximately 30 minutes for completing all the tests.

***Star Excursion Balance Test***

The subject was asked to stand on one foot in the centre of the star with their hands on their hips. Then, the subject was encouraged to reach with one foot as far as possible in one direction and lightly touch the line before returning to the starting position. The point on the line where the subject could reach was marked by the assessor. This procedure was repeated until the subject completed all lines in every reach direction. The test was repeated three times for each foot. This test assessed balance in 08 directions bilaterally: Right side: anterior (R-A), posterior (R-P), medial (R-M), lateral (R-L), anteromedial (R-AM), anterolateral (R-AL), posteromedial (R-PM) and posterolateral (R-PL). Left side: anterior (L-A), posterior (L-P), medial (L-M), lateral (L-L), anteromedial (L-AM), anterolateral (L-AL), posteromedial (L-PM) and posterolateral (L-PL). A one-minute rest period was provided between each trial for one foot in the past. After completing three trials for one foot, another five-minute rest period was granted, and then the test was performed for the other leg. (Gribble & Hertel, 2013)

***Alternate Hand Wall Toss Test***

A line was drawn on the ground 2m distance from the wall. The subject was asked to stand behind the line, facing the wall. The ball was thrown from one hand of the subject against the wall, and it was caught with the opposite hand. This procedure was continued for 30 seconds. Finally, the number of successful catches in the 30-second period was counted. This test was performed only once.

***Illinois Agility Test (IAT)***

The length of the IAT was set to 10 m. Before the test, four centre cones were placed with a spacing of 3.3 meters apart, and four corner cones were positioned 2.5 meters from the centre cones. Initially, the subject was asked to lie prone on the floor behind the starting line with the arm at sight and head facing forward. The stopwatch was started with the "go" command, and the athlete had to get up as quickly as possible, run forward 10 meters to go around the cones, then run back 10 meters, and finally run up and back through a slalom course of four cones. Eventually, the subject ran another 10 meters up and back to finish the test. (Raya et al., 2013) The best performance of the three trials was recorded for statistical analysis. A 2-minute rest period was given between trials.

***Overhead Medicine Ball Throw Test***

The subject was asked to stand at a line with feet side by side and slightly apart while facing the direction in which the ball would be thrown. The subject was instructed to hold the ball with their hands on the side and slightly behind the centre.

The ball was brought back behind the head and then thrown vigorously forward as far as possible. The subject was allowed to step forward over the line after the ball was released. Three attempts were allowed, and the distance between the starting position and the point where the ball landed was recorded. The measurements were recorded to the nearest 10 cm. The best result of three throws was used.

***Nelson Hand Reaction Time Test / Ruler Drop Test***

The subject was instructed to stand with an outstretched arm and to hold out the thumb and first finger of the dominant hand. The examiner held the 1m end of the ruler, and the 0 cm end of the ruler was positioned just above the gap between the outstretched thumb and first finger. The subject was instructed not to touch the ruler.

Without any warning, the ruler was dropped, and the subject was instructed to catch the ruler as quickly as possible using the thumb and first finger. The point at which the ruler was caught was recorded to the nearest cm, with the measurement taken from the bottom of the thumb.

Each subject was asked to perform three trials, and the best performance was recorded for further statistical analysis. (Szabo, Neagu, Teodorescu, Panait, & Sopa, 2021)

***Kinovea***

The subject was asked to stand at a line with feet cross overstep with the throwing hand in 90 degrees shoulder abduction and 90-degree elbow flexion while facing the direction in which the ball would be thrown. The circumference and the weight of the ball was 72cm and 450g.The camera was placed perpendicular to the subject with the distance adjusted. With the start signal, the subject was asked to throw the ball towards the point which was marked at 6m distance from the starting line and the video was recorded. Two trials were given, and the best result was recorded for the analysis. The ball throwing speed was analysed by Kinovea 0.9.5-x64.exe software. (Raharja, Sulaiman, Sumartiningsih, & Winarno, 2022).

***Data Analysis***

Data was analysed using SPSS software (version 26). Demographic information is presented as mean and standard deviation. Shapiro-Wilk test was used to determine the normality distribution of data. One-way ANOVA test was conducted to compare each skill related physical fitness factors between the players of four sports (volleyball, badminton, netball, basketball). Further, Scheffe test was conducted for pair wise comparison of the factors that showed statistically significant association in One-way ANOVA. Independent sample T-test was used to compare each skill related physical fitness factors between the overhead throwing athletes and control group.

***Data Availability***

The data associated with the paper are not publicly available but are available from the corresponding author on reasonable request

## 3.0 RESULT AND DISCUSSION

***Results***

A total of 77 athletes in University of Peradeniya and 80 controls were selected for the study. The mean age of athletes and controls was 23.05±1.52, 24.47±1.84 years respectively, the mean height of athletes was 1.65±0.09 m, the mean height of controls was 1.63±0.09 m, the mean weight of athletes was 58.15±8.64 kg and mean weight of controls was 58.45±11.58 kg. Details of gender and number of athletes from each sport are given in Table 1.

Table 1. Details of participants

| No | **Name of sports** | **Male** | **Female** | **Total** |
|---|---|---|---|---|
| 1 | Netball | 0 | 12 | 12 |
| 2 | Badminton | 08 | 08 | 16 |
| 3 | Volleyball | 12 | 12 | 24 |
| 4 | Basketball | 13 | 12 | 25 |
| 5 | Controls | 40 | 40 | 80 |

The skill-related physical fitness factors were compared between badminton, basketball, volleyball, and netball players in University of Peradeniya using one-way ANOVA test. The results of the analysis are presented in Table 2.

Table 2. Comparison of skill-related physical fitness factors.

| **No** | **Variable** | **Badminton mean±SD** | **Volleyball mean±SD** | **Basketball mean±SD** | **Netball mean±SD** | **p-value** |
|---|---|---|---|---|---|---|
| 1 | Balance R-PM(cm) | 75.95±16.43 | 90.85±24.94 | 95.94±19.59 | 90.37±20.26 | 0.03* |
| 2 | Balance R-M(cm) | 65.56±10.03 | 81.60±23.04 | 79.52±14.59 | 71.83±12.76 | 0.01* |
| 3 | Balance L-L(cm) | 97.31±22.52 | 118.48±24.43 | 116.51±24.96 | 105.80±22.06 | 0.03* |
| 4 | Balance L-P(cm) | 82.26±14.65 | 99.75±24.06 | 104.26±26.03 | 97.36±16.14 | 0.02* |

*p-value <0.05

R-A= right anterior, R-AL= right anterolateral, R-L= right lateral, R-PL= right posterolateral, R-P=right posterior, R-PM= right posteromedial, R-M= right medial, R-AM= right anteromedial, L-A= left anterior, L-AL= left anterolateral, L-L= left lateral, L-PL= left posterolateral, L-P= left posterior, L-PM= left posteromedial, L-M= left medial, L-AM= left anteromedial.

There was a significant difference in balance R-PM, balance R-M, balance L-L, and balance L-P between badminton, basketball, volleyball, and netball players ($p<0.05$).

There was no significant difference in Balance R-A (p=0.27), Balance R-AL (p=0.09), Balance R-L (p=0.12), Balance R-PL (p=0.26), Balance R-P (p=0.05), Balance RAM (p=0.16), Balance L-A (p=0.18), Balance L-AL (p=0.10), Balance L-PL (p=0.10), Balance L-PM (p=0.13), Balance L-M (p=0.40), Balance LAM (p=0.29), Coordination (p=0.08), Agility (p=0.68), Power (p=0.11), and Reaction time (p=0.94), Speed (0.42).

Further, Scheffe Test was conducted for pairwise comparison of the factors that showed statistically significant difference (Table 3).

Table 3. Pair wise comparison of balance-right side posteromedial, balance-right side medial, balance-left side lateral, and balance-left side posterior between badminton, basketball, volleyball, and netball

| No | Variable | Sports | Sports | Mean difference | p-value |
|---|---|---|---|---|---|
| 1 | Balance R-PM (cm) | Badminton | Basketball | -19.98 | 0.03* |
| 2 | | Basketball | Badminton | 19.98 | 0.03* |
| 3 | Balance R-M(cm) | Badminton | Volleyball | -16.03 | 0.04* |
| 4 | | Volleyball | Badminton | 16.03 | 0.04* |
| 5 | Balance L-P(cm) | Badminton | Basketball | -22.00 | 0.02* |
| 6 | | Basketball | Badminton | 22.00 | 0.02* |

*p value <0.05

R-PM= right posteromedial, R-M= right medial, L-L= Left lateral, L-P= Left posterior

There was a significant difference in balance R-PM direction between the basketball and badminton players ($p<0.05$). It was found that, the balance of basketball players in R-PM direction was higher than badminton players. There was a significant difference in balance R-M direction between the badminton and volleyball players and the volleyball players showed higher balance in R-M direction than badminton players ($p<0.05$). When considering balance on L-P direction, a significant difference was seen between badminton and basketball players ($p<0.05$). It was found that, the balance of basketball players in L-P direction was higher than badminton players.

However, there was not significant difference in Balance R-PM between badminton and volleyball (p=0.19), badminton and netball p (p=0.36), volleyball and basketball (p=0.86), volleyball and netball (p=1.00), and basketball and netball players (p=0.90). In the Balance R-M there was no significant difference between badminton and basketball (p=0.09), badminton and netball (0.81), volleyball and basketball (0.97), volleyball and netball (0.44), and basketball and netball players (0.63). In the Balance L-L direction there was not significant difference between badminton and volleyball (0.06), badminton and basketball (0.10), badminton and netball (0.83), volleyball and badminton (0.06), volleyball and basketball players (0.99), volleyball and netball (0.52), and netball and basketball players (0.65). In the Balance L-P direction badminton and volleyball (0.12), badminton and netball (0.36), volleyball and basketball (0.91), volleyball and netball (0.99), and basketball and netball players (0.85).

The skill- related physical fitness factors were compared between athletes of the four sports and the control group using independent sample test the results of the analysis are presented in Table 4.

Table 4. Comparison of skill-related physical fitness factors between athletes and controls

| No | Variable | Group | N | Mean ± Std. Deviation | Independent sample t-test for Equality of Means (Sig/ p-value) |
|---|---|---|---|---|---|
| 1 | Balance R-A (cm) | Athletes | 77 | 107.99 ± 24.59 | 0.00* |
| | | Controls | 80 | 95.00 ± 21.18 | |
| 2 | Balance R-AL (cm) | Athletes | 77 | 110.62 ± 24.17 | 0.00* |
| | | Controls | 80 | 95.18 ± 21.62 | |
| 3 | Balance R-L(cm) | Athletes | 77 | 113.02 ± 24.84 | 0.00* |
| | | Controls | 80 | 96.86 ± 23.07 | |
| 4 | Balance R-PL(cm) | Athletes | 77 | 110.18 ± 27.40 | 0.00* |
| | | Controls | 80 | 92.37 ± 23.21 | |
| 5 | Balance R-P (cm) | Athletes | 77 | 95.74 ± 24.25 | 0.00* |
| | | Controls | 80 | 81.14 ± 22.49 | |
| 6 | Balance R-PM(cm) | Athletes | 77 | 89.33 ± 21.79 | 0.00* |
| | | Controls | 80 | 73.36 ± 19.75 | |
| 7 | Balance R-M(cm) | Athletes | 77 | 76.07 ± 17.63 | 0.00* |
| | | Controls | 80 | 66.70 ± 15.23 | |
| 8 | Balance R-AM(cm) | Athletes | 77 | 102.06 ± 23.48 | 0.00* |
| | | Controls | 79 | 82.71 ± 20.75 | |
| 9 | Balance L-A (cm) | Athletes | 77 | 112.30 ± 24.26 | 0.00* |
| | | Controls | 80 | 95.07 ± 23.78 | |
| 10 | Balance L-AL (cm) | Athletes | 77 | 112.04 ± 24.32 | 0.00* |
| | | Controls | 80 | 93.20 ± 23.33 | |
| 11 | Balance L-L (cm) | Athletes | 77 | 111.47 ± 24.88 | 0.00* |
| | | Controls | 80 | 91.52 ± 22.97 | |
| 12 | Balance L-PL (cm) | Athletes | 77 | 106.79 ± 24.89 | 0.00* |
| | | Controls | 80 | 86.75 ± 23.13 | |
| 13 | Balance L-P (cm) | Athletes | 77 | 97.21 ± 23.12 | 0.00* |
| | | Controls | 80 | 78.76 ± 22.32 | |
| 14 | Balance L-PM (cm) | Athletes | 77 | 90.83 ± 22.15 | 0.00* |
| | | Controls | 80 | 73.84 ± 19.66 | |
| 15 | Balance L-M (cm) | Athletes | 77 | 78.90 ± 14.41 | 0.01* |
| | | Controls | 80 | 69.26 ± 26.45 | |
| 16 | Balance L-AM (cm) | Athletes | 77 | 103.34 ± 24.08 | 0.00* |
| | | Controls | 80 | 84.41 ± 23.97 | |
| 17 | Coordination | Athletes | 77 | 21.68±13.13 | 0.00* |
| | | Controls | 80 | 11.56 ±8.59 | |

*p value <0.05

R-A= right anterior, R-AL= right anterolateral, R-L= right lateral, R-PL= right posterolateral, R-P=right posterior, R-PM= right posteromedial, R-M= right medial, R-AM= right anteromedial, L-A= left anterior, L-AL= left anterolateral, L-L= left lateral, L-PL= left posterolateral, L-P= left posterior, L-PM= left posteromedial, L-M= left medial, L-AM= left anteromedial

A significant difference was found between athletes and control in balance R-A, balance R-AL, balance R-L, balance R-PL, balance R-P, balance R-PM, balance R-M, balance R-AM, balance L-A, balance L-AL, balance L-L, balance L-PL, balance L-P, balance L-PM, balance L-M, balance L-AM, coordination ($p<0.05$). Among them, athletes had higher mean value for balance R-A, balance R-AL, balance R-L, balance R-PL, balance R-P, balance R-PM, balance R-M, balance R-AM, balance L-A, balance L-AL, balance L-L, balance L-PL, balance L-P, balance L-PM, balance L-M, balance L-AM , and coordination compared to controls. There was no significant difference in agility, power, reaction time and speed between athletes and control ($p>0.05$).

There was not stastically significant difference between the athletes in control for agility ($p=0.11$), power (0.21), reaction time ($p=0.24$) and speed ($p=0.21$).

## *Discussion*

The study results found that basketball players had better dynamic balance performance in right posteromedial and left posterior directions compared to badminton players. Also, volleyball players showed better dynamic balance performance in right medial direction compared to badminton players.

A study reported similar findings where basketball players had better balance control of the SEBT posteromedial and posterolateral reach. (Curtolo et al., 2017) Another study conducted in India among 40 players found that the dynamic balance of volleyball players was better than the basketball players. Further it was explained that the balance scores difference among players might be due to the differences in joint strength. Volleyball players require rapid changes of direction constantly throughout the game to hit the ball. A good dynamic balance is needed during the sequence of passing, setting, spiking, and blocking in volleyball. Although these actions are less seen in basketball players. (Curtolo et al., 2017) Basketball requires the players to habitually address physical contact and various situations involving balance instability, like basketball-specific accelerations and decelerations, changes in direction, penetration into the defensive perimeter, boxing out dribbling, and defences position recovery. (Curtolo et al., 2017) The skill requirements and environmental demands of sports likely pose different challenges to the sensory motor systems that cumulatively may influence the balance abilities of trained athletes. In the present study, the findings may be due to the difference in the types of sport-specific skills practices.

The findings of this study revealed that balance R-A, balance R-AL, balance R-L, balance R-PL, balance R-P, balance R-PM, balance R-M, balance R-AM, balance L-A, balance L-AL, balance L-L, balance L-PL, balance L-P, balance L-PM, balance L-M, balance L-AM were significantly different between athletes and controls. Athletes had higher mean values for balance compared to controls. A Malaysian study done among a total of 20 healthy young females aged 15 to 17 years old who were grouped into sedentary control and netball player groups found that netball players who were physically active exhibited better balance ability compared to sedentary individuals. The UPST (Unipedal Stance Test) results showed that sedentary and netball groups showed better standing balance ability for EO (eye open) compared to EC (eye closed). (Kamarudin et al., 2021) The duration of engagement in physical and sporting activities play a crucial role in positively affecting postural control. (Kamarudin et al., 2021) This may account for the higher mean balance observed among athletes compared to controls in the current study.

The present study revealed a statistically significant disparity in coordination between athletes and the control group. In this instance, athletes exhibited a notably higher mean coordination score in comparison to the control group. A previous study conducted among 30 badminton players (younger cadets, cadets, and juniors) and 54 peers who were non-athletes reported differences in the level of motor coordination abilities between badminton players and non-athlete peers within individual age groups (younger cadets, cadets, juniors). Furthermore, this study revealed a higher level of motor coordination abilities in badminton players compared to the control group, these finding are in line with the present study. (Jaworski, Lech, Ambrozy, & Zak, 2020) High level of coordination motor abilities may be related to high level of physical activity. (Jaworski, Lech, Żak, Madejski, & Szczepanik, 2017) It may be a reason for significant difference in coordination between athletes and controls, with athletes having better coordination.

This analysis of the present study highlighted a substantial, statistically non-significant difference in agility between athletes and the control group. A previous study conducted among thirty male basketball players playing at university level, their age ranged from 18-19 years and thirty age matched subjects served as control group used quadrant jump, burpee's squat thrust, and shuttle run to assess agility. It was found that the agility of the basketball players was not significantly different from controls except burpee's squat thrust. (Kamble, Daulatabad, & Baji, 2012) Reaction time and accuracy, foot placement patterns, and certain functional movements (e.g., in-line lunge) have been shown to be related to agility performance. (Paul, Gabbett, & Nassis, 2016) In the current study, it was observed that there was no statistically significant difference in reaction time between athletes and the control group. This lack of difference in reaction time may contribute to the non-significant disparity in agility between athletes and the control group.

In the present study athletes exhibited a notably greater mean power compared to the control group. Despite the differences in mean values, there was no statistically significant difference in power between athletes and controls. In contrast to our findings, a study conducted among 30 healthy male routinely trained badminton players and 30 non-badminton players found that the shoulder strength in routinely trained badminton players was significantly different from non-badminton players. (Feng, Rasyid, & Juliati, 2017) Heavy resistance training for the upper and the lower limbs improves muscle strength and power. (Hermassi, Chelly, Tabka, Shephard, & Chamari, 2011) In the present study, athletes have predominantly prioritized sport-specific drills, such as ball handling, dribbling, and shooting. The notable absence of resistance training in athletes might explain the lack of a statistically significant difference in power between athletes and the control group.

The present study suggested that there was no statistically significant difference in reaction time between athletes and controls. A study conducted among 50 male badminton players of 18–22 years age group and 50 age-matched healthy males who formed the control group revealed that visual reaction time of dominant as well as non-dominant limb of badminton players was significantly lesser than that of the control group who were not practicing any sports activity. (Dube, Mungal, & Kulkarni, 2015) A Malaysian study done among a total of 20 healthy young females aged 15 to 17 years old who were grouped into sedentary control (n=10) and netball player (n=10) groups found that netball players who were physically active exhibited faster reaction time compared to sedentary individual. (Kamarudin et al., 2021) The results from prior studies contrast with those of the current study. Stronger arm strength measures are related to faster upper body reaction and movement time. (Legg, Arnold, Trask, & Lanovaz, 2021) In the present study, the lack of a significant difference in upper body power between athletes and controls may explain the absence of a significant difference in reaction time between the two groups.

The analysis of present study revealed that there was statistically no significant difference in speed between athletes and controls. The maximum overhead throwing speed is achieved through the successful coordination of all body joints and segments in the movement and requires high technical skills. In addition, the muscle force generated by the upper limbs results in the throwing of the ball. Better hand grip strength, arm span and hand length exhibit advantage in overhead throwing speed. (Zapartidis, Palamas, Papa, Tsakalou, & Kotsampouikidou, 2016) Hence, these factors could be a contributing reason for the absence of a statistically significant difference in speed between the athletes and the control group in the present study.

This study was limited to a small sample of players among university athletes. Hence, these findings cannot be generalized. Thus, future studies on larger sample are encouraged. And also specific training programs may be formulated and evaluated for effectiveness among athletes. The strength of the study is that it was conducted among the University Team athletes of one of the State Universities in the Country that compete in interuniversity games. Further, participating and excelling in the game depends on various factors, of which skill-related physical fitness factors and sports-specific training are specifically important. Hence, the study has explored and succeeded in providing quantitative data. These findings will be beneficial for other researchers and conveys the need for sports specific training to enhance performance**CONCLUSION**

The present study concluded that, the basketball players exhibited better dynamic balance performance in R-PM and L-P directions than badminton players. Also, the volleyball players showed better dynamic balance performance in R-M direction than badminton players. When comparing skill-related physical fitness components between athletes and control, the athletes exhibited better performance in balance in all directions and coordination compared to control. However, there was no statistically significant difference between athletes and control for agility, power, reaction time and speed. The findings suggest that specific skill-related physical fitness factors are not adequate among the athletes of different sports, suggesting a need to formulate specific and improved training programs. Further, the athletes did not have better agility, power, reaction time and speed compared to controls. This finding emphasizes the immediate need to formulate specific training programs, specific to the sports to improve skills of the athletes. This is essential to improve performance of the University athletes and to prevent injuries that may occur due to inadequate skill-related physical fitness.

## AUTHORS' CONTRIBUTION

Liyanage E and Manchanayake M.M.J.P contributed to the conception and design of the work. Mathusa S, Thevasutharsana V, Thihna M.M.S.R, Walpola W.K.N.E, Wijerathna H.M.S.S, Wijerathna S.D.L contributed to collect data, analyse and draft the work. Liyanage E and Manchanayake M.M.J.P revised it critically for important intellectual content. All authors read and approved the final version of the manuscript

## CONFLICT OF INTEREST

There is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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