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Correlation between dynamic balance, grip strength and eye-hand coordination with smash performance in elite badminton players: An observational study

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Abstract
The correlational study aims to find the contribution of dynamic balance, grip strength, and eye-hand coordination of elite badminton players to their smash performance. The sample size comprised 30 young elite badminton players of Ahmedabad including both genders. The data were collected using the measurement test on four variables: the dynamic balance data was using the y-balance test, grip strength using a hand-held dynamometer, eye-hand coordination using the anterior wall toss test, and smash performance using the smash accuracy and speed test. Statistical analysis was done using SPSS version 16.0 and Microsoft Excel 10. The level of significance was kept at 5% and the confidence interval (CI) at 95%. Correlational and regression analysis was done to determine the contribution of the above-mentioned variables. The results showed that the grip strength with a p-value of 0.04 and r value of 0.38 has moderate, dynamic balance with a p-value of 0.001 and r value of 0.65 has strong and eye-hand coordination with a p-value of 0.01 and r value of 0.37 has low correlation respectively with smash performance of badminton players.

Keywords: Badminton, smash, dynamic balance, grip strength, eye hand coordination

Introduction
Badminton is one of the fastest racket sports in the world; the speed of badminton smashes can be as high as 30m/s. It is considered one of the most popular racket sports in the world, in which two or four opposing players strike a shuttlecock over a dividing net between them to score a point. The overhead technique is one of the three main categories of badminton strokes, which are divided into three strokes drop, clear, and smash [1].

This sport has requiring specific preparation in terms of patience, control, and motor actions. In this sport factors such as reaction time, foot stepping and balance are essential motor characteristics for co-ordination [2]. In the Rio Summer Olympic Games in 2016, the most injured region in badminton players was the lower limb (mostly knee joint and non-contact ACL injury). The most common injury mechanism in badminton was a single-limb landing after an overhead stroke (smash or clear shot), whereas sudden deceleration with the change of direction (plant-and-cut) was the second most common injury mechanism [3]. Therefore, superior body balance is crucial for badminton skill advancement, sports performance, [4] and injury prevention.

For producing powerful shots in badminton wrist action is exorbitantly important. The accuracy of a smash targeted by a player will certainly be very beneficial for the player because he will be able to direct his smash to the difficult areas for the opponent to reach. Grip forces exerted by the finger flexor muscle are isometric and according to the force-length relationship, a badminton player should hit the shuttlecock [5]. The fine control of the badminton grip is dependent on not only the grip posture but also the grip strength of the fingers, which can be characterized by the flex status of the fingers and the pressure distribution of the palm and fingers [6]. To win a match, of course, it is not enough just to have a strong smash, it must be accompanied by good accuracy (Manurizal, 2016) for a smash to be accurate, it requires good coordination and grip strength [5].

In badminton games, the time required to process visual information can be an important factor in distinguishing the performance of badminton players from each other [7].

It is the central nervous system ability of eye-hand coordination to synchronize the information received from the eyes to control, guide, and direct the hands to perform of a given task such as hitting the shuttle with the racquet [8]. The ability to follow the shuttlecock with the eyes is a perceptual ability related to hand-eye coordination in badminton smash receptions for better target reaching and hitting the maximum peak point of the smash trajectory and win points [9].

Fig 1: Jump Smash

2. Material and Methodology

This observational study was designed with the approval of the institute and informed consent was obtained from each subject who participated in the study. Thirty players from different sports academies across Ahmedabad were screened for inclusion criteria having an age group of 18 to 25 years, both genders were included, having at least 1 year of experience in professional badminton training and/or a national participation. Subject details are mentioned in (Table 1) below. Any subject who had a history of lower/upper limb injury in the past 6 months, undergone any limb surgery in the last 1 year or had any cardiovascular/neurological or vestibular disorders were excluded from the study.

Table 2.1: Distribution of baseline demographic variables

	Age (yrs)	Weight	Height	Experience (yrs)	BMI
Mean	21.25	65.02	171.58	4.562	22.08
SD	2.66	11.14	7.52	2.69	3.81

Subjects to be included in the Study were explained the whole procedure, informed written consent was taken, and were included in the study according to their willingness. The participants were asked to provide their demographic information and medical history, if any. Through questionnaires, the badminton training experience of each participant including the number of years of badminton training received, time spent in training each week, and competition records were determined. A fitness test was taken before starting the training: Physical Activity Readiness Questionnaire (PAR-Q). After adequate badminton-specific warm-up 4 below-mentioned tests with known reliability and validity were undertaken with the help of two well-trained research assistants in random order with 5 minutes of rest between each test.

Dynamic balance test

Y Balance Test (lower quarter) was performed under the supervision of the principal investigator and assistants following standardized procedures as described in the Functional Movement Systems manual [10]. The Y Balance Test being dynamic in nature is performed on single-leg standing position. The test has shown good interrater test-retest reliability (intraclass correlation coefficients=0.80-0.85) and minimal measurement errors among young healthy individuals [11]. The participants were instructed to maintain a single-leg stance while reaching as far as possible with the contralateral leg and to return to the starting position on the center platform without losing balance. The test requires the participant to reach in 3 directions-anterior, posteromedial, and posterolateral-with 3 trials allowed for each leg. The maximum reach distance for each successive trial will be recorded. A composite score for each leg will be derived using the following equation: composite score = [(sum of the greatest reach in each direction), (3 × limb length)] × 100 [10].

Hand grip strength

All subjects were assessed for their handgrip strength using a Jamar hand-held dynamometer. Three trials will be given for each of the participants and an average score was recorded [12]. The subjects were made to sit on a chair with the elbow flexed at 90 degrees and the forearm in semi-pronation (neutral position) lying on an armrest [13]. There was a minute resting period given in between each squeeze to overcome the fatigue. The mean value of three squeezes was recorded.

Fig 2: Testing for grip-strength with jamar dynamometer

Alternate hand wall toss test

In this test, the players were instructed to throw and catch a tennis ball off a wall. The athlete had to stand two meters away from a smooth wall. The assistant gives the command "GO" and starts the stopwatch. The athlete alternatively throws a tennis ball with their right hand against the wall and catches it with the left hand for 30 seconds of time period. The number of catches are noted after the completion the test [14].

Fig 2.2: Anterior Wall Toss Test

Table 2.2: Interpretation of alternate wall toss test scores

Performance	Excellent	Above average	Average	Below average	Poor
No of catches	>35	30-35	25-29	20-24	<20

Forehand smash performance test

The forehand smash stroke performance test was established to analyze both, strike velocity and accuracy. The dimension of a square target (60 × 60 cm) is fixed on the upper right corner of the single badminton court using a different colored tape. The square target colors are marked with three different colors (red, blue, and yellow); red color 3 points, blue 2 points, and yellow 1 point, and each color target size is 20 cm in width and 60 cm in length [1]. ACTOFIT badminton sensor was used instead of a radar gun to measure strike velocity. Before the beginning of the smash test, the sensor was attached at the grip end of the racquet by the manufacturer's instructions manual. After completing warm-up of about 10-15 minutes, the players were asked to perform 10 maximum forehand smash strokes separated by 5-10 seconds rest within the smashing strikes, which is based on specific demands of badminton players during competition [15]. An investigator was standing directly in the right service court (on the black point) and behind the left service court where the colored target was situated. The investigator served 10 forehands to the player who was standing on (small red start point) which was fixed in the right service court of the opposite court. Following it, the player had to move to backward in the single court and smash the shuttle onto the marking at long service line area. A strike smash inside the medial target area was scored with 3 points, central 2 points and lateral 1 point, whereas a strike smash outside the square-colored target was scored with zero points. The dimensions of the court along with the markings for smash accuracy and the sensor used are given in Figure 2.1.

3. Results and Discussion

Statistical analysis was done using SPSS version 16.0 and Microsoft Excel 10. The level of significance was kept at 5% and the confidence interval (CI) at 95%. Descriptive statistics was used to analyze all the demographic and outcome variables. Given the relatively small sample size, both Shapiro-Wilk tests and histograms were used to evaluate the normality of the data. Pearson correlation test is applied to find if there is any significant correlation between the independent variables dynamic balance (X1), grip strength (X2), and eye-hand coordination (X3) with the dependent variable smash performance Y. From the R-values obtained of individual independent variables X1, X2, X3 with Y, it is significant that dynamic balance shows (X1) high degree of correlation with smash performance (Y), grip strength (X2) shows a high degree of correlation with smash performance (Y) while hand-eye (X3) shows a low degree of correlation with smash performance (Y).

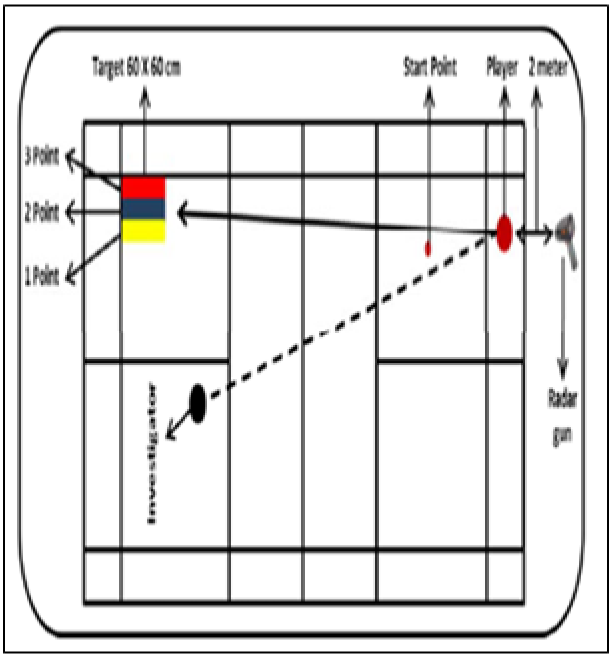


Fig 2.3: Forehand smash test for accuracy

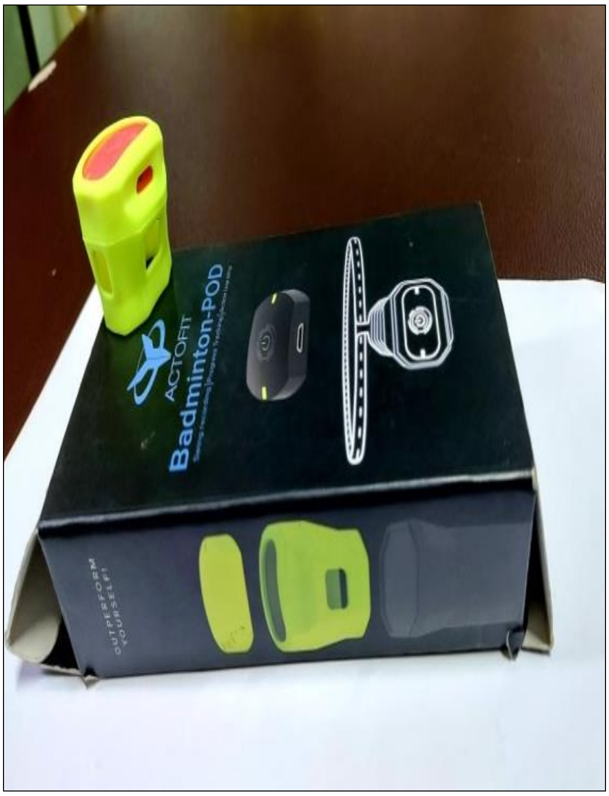
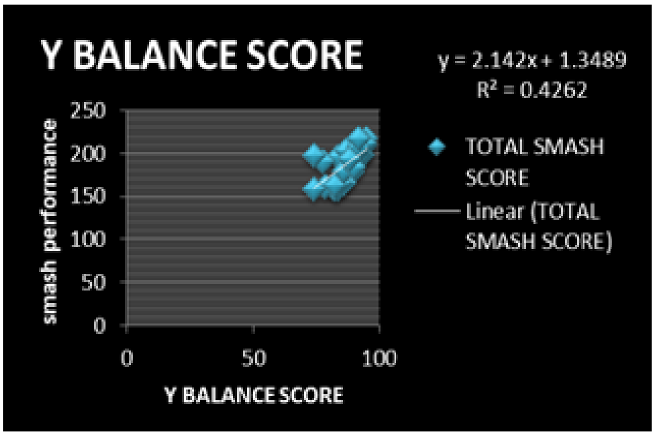
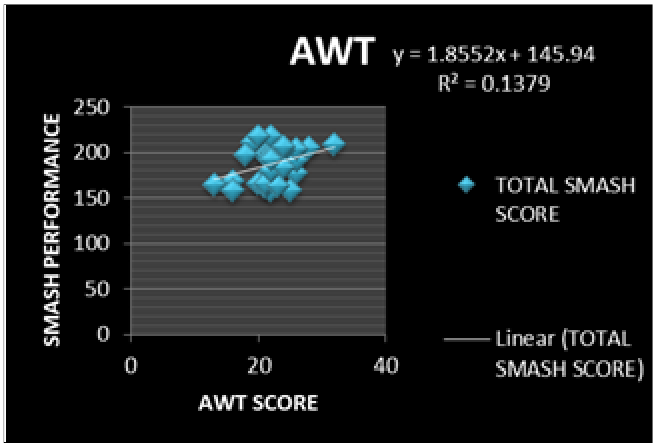


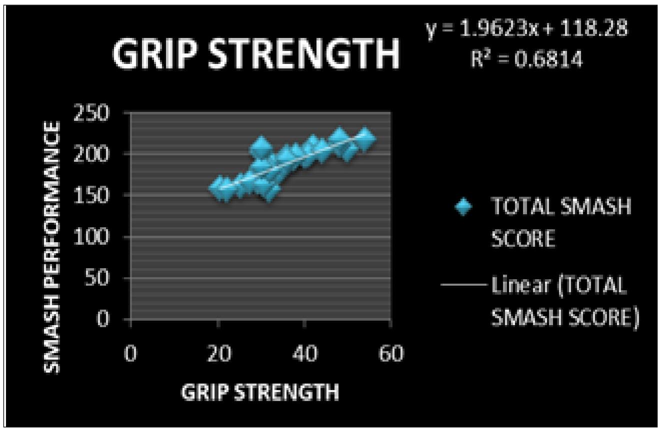
Fig 2.4: Actofit badminton pod sensor for smash speed



Graph 3.1: Y-Balance score to smash performance



Graph 3.2: Eye-hand coordination to smash performance



Graph 3.3: Hand grip strength to smash performance

Multi-linear regression analysis was done to examine the cumulative correlation of the above-mentioned sports-specific variables towards smash performance which showed that dynamic balance (X1) with p-value 0.004 and r-count 0.53 affects the smash performance (Y) maximally.

Table 3.1: Multilinear regression analysis of independent variables to smash performance

Independent variables (Constant)	T value	P value	$R_{PARTIAL}$	$R_{SEMIPARTIAL}$
Y_Balance_Score	3.16	0.004	0.53	0.47
Right_Grip_Strength	0.10	0.913	0.02	0.01
AWT	0.81	0.421	0.16	0.12

From the results obtained in the study done on 30 elite badminton players we found that dynamic balance, grip strength, and hand-eye coordination are significantly correlated to the smash performance of elite badminton players. Where grip strength contributes 14.44%, eye-hand coordination contributes 13.69% while dynamic balance has a strong contribution of 42.25% towards smash performance individually. Febby Pratama, studied the correlation between explosive upper arm strength, explosive leg muscle strength, and eye-hand coordination towards smash of badminton players which shows a strong correlation between upper extremity strength and smash performance which supports our results of grip strength contribution towards smash performance.

Jeki Haryanto in his study of Footwork and grip strength: is it related to smash accuracy has similar results of the strong association of grip strength towards smash accuracy, which is a component of smash performance in the present study. Hence it can be said that grip strength strongly affects smash speed and accuracy. Mimi Yulianti, in this study Contribution of Leg Muscle Explosive Power and Eye-Hand Coordination to The Accuracy Smash of Athletes in Volleyball Players, proved that eye-hand coordination contributed 20.79% towards smash accuracy which is supportive to our results of eye-hand contribution towards smash performance in elite badminton players.

In a study conducted by Towel K.K. Wong amateur badminton players had superior dynamic balance and hence better sports performance, which favours our results of some correlation of eye-hand coordination with smash performance and strong correlation of dynamic balance with smash performance. To become an elite badminton athlete, the fitness requirement is quite specific. Over the past few years, badminton as played in Asia has focused a greater emphasis on fitness (16), hence it is necessary to find the correlation of every parameter affecting the performance and their contribution to create a better performance framework for enhancing these sport-specific skills.

Although, being a non-contact sport injuries in badminton are common which are more of overuse and acute traumatic in nature. The game demands complex repetitive upper and lower extremity movements with constant postural variations which is physically strenuous and poses risk of overuse injuries to appendicular and axial musculoskeletal systems collectively. It is a necessity in badminton, to perform short bursts of movement with sudden sharp changes in direction, which places players at risk of non-contact traumatic injuries to joints and muscle-tendon units. Preventing injuries and decreasing time away from training and competition are crucial in an elite badminton player's sporting career [17].

In hospital-based retrospective study conducted by Kroner *et al* [16] showed an injury incidence of 4.1%, with 82.9% being lower extremity injuries. 128 injuries occurred in the ankle joint which constituted 62% of all documented injuries. In addition to this, 11 patients with Achilles tendon injuries required hospital-based treatment. In an investigation conducted by Sharif *et al.* [17,18] into the pattern of musculoskeletal injuries sustained by Malaysian badminton players, they concluded that the majority of the injuries occurred during training (86.6%). Injuries were sustained most commonly around the knee and were related to overuse injuries, noting a higher incidence amongst younger players but no difference amongst genders. In their retrospective study, they noted that 63% of injuries involved the lower limb with the nature of injury being overuse (36%), strain (30.9%), and sprain (26%). They noted a total of 10 severe injuries in the two-and-a-half-year study period. These included Achilles tendon ruptures, anterior cruciate ligament tears, meniscal tears, and metatarsal fractures. Therefore, dynamic balance of lower extremity training might help improve balance and prevent injuries occurring in the lower limb.

Ocular trauma in sports is relatively rare but is associated with high levels of morbidity and disability. Badminton has been classified as a high-risk sport for ocular injury due to the small, dense shuttlecock that travels at such high speed near players [17]. In a study [19] of 85 patients with ocular injuries in badminton, 73 injuries occurred in doubles matches with 60 injuries resulting from shuttlecock impact. 80/85 injuries were non-penetrating in nature and 52 of the injuries occurred in doubles games and were partner-involved. Amongst the 52 players who were hit by their partner, 51 were in the front court, and most turned to their partner as they were hitting a shot. Hence better eye hand coordination may help prevent eye injuries.

4. Conclusion

Based on the results of this study done by over 30 elite badminton players, it can be concluded that dynamic balance, eye-hand coordination, and grip strength are significantly correlated to the smash performance of elite badminton players.

5. Limitations and Future Recommendations

1. The sample size of the study is small hence larger sample can be taken.
2. Unequal gender distribution, both male and female of same ratio can be included in the study.
3. Parameters such as psychological status, agility, core strength, explosive power can be included to understand and correlate the sport specific profile of an elite badminton player.

6. References

1. Ibrahim HHI. The Effect of Core Stability Training on Dynamic Balance and Smash Stroke Performance in Badminton Players. Int J Sports Sci Phys Educ; c2017.
2. Seth B. Determination factors of badminton game performance. Int J Phys Educ Sports Health. 2016;3(1):20-22.
3. Alikhani R, Shahrjerdi S. The effect of a six-week plyometric training on dynamic balance and knee proprioception in female badminton players. J Can Chiropr Assoc. 2019 Dec;63(3):144-153.
4. Chang WD, Chang WY, Lee CL, *et al*. Validity and reliability of WII fit balance board for the assessment of balance of healthy young adults and the elderly. J Phys Ther Sci. 2013;25:1251-.
5. Waddell DB, *et al*. Biomechanical Principles Applied to Badminton Power strokes.
6. Haryanto J. Footwork and grip strength is it related to smash accuracy. J Educ Learn Stud. 2021;4(1):123-128.
7. Carey DP. Eye-hand coordination: eye to hand or hand to eye? Curr Biol. 2000;10:R416-9.
8. Wong *et al*. Balance control, agility, eye-hand coordination, and sport performance of amateur badminton players: A cross-sectional study. Medicine. 2019;98(2).
9. Ishibe K, *et al*. The development of an immersive three-dimensional virtual reality system for identifying hand-eye coordination in badminton. 2020 IEEE International Conference on Systems, Man, and Cybernetics (SMC) October 11-14, 2020. Toronto, Canada.
10. Functional Movement Systems, Cook G, Plisky PY Balance Test Manual. Functional Movement Systems, USA; c2010.
11. Shaffer SW, *et al*. Y-Balance Test: A reliability study involving multiple raters. Mil Med. 2013;178:1264-70.
12. Kuzala EA, Vargo MC. The relationship between elbow position and grip strength. Am J OccupTher. 1992;46(6):509-12.
13. Bohannon RW, Andrews AW. Interrater reliability of handheld dynamometry. Physical Therapy; c1987.
14. Mackenzie B. Hand Eye Coordination Test [WWW] [Accessed 26/9/2020]. Available from: https://www.brianmac.co.uk/handeye.htm
15. Brahms BVa. Badminton handbook: training, tactics, competition, 2nd Edition; c2014.
16. Chin MK. Sport specific fitness testing of elite badminton players. Br J Sports Med. 1995;29(3):153-157.
17. Pardiwala DN, Subbiah K, Rao N, *et al*. Badminton Injuries in Elite Athletes: A Review of Epidemiology and Biomechanics. JOIO. 2020;54:237-245.
18. Sharif AH, George J, Ramlan AA. Musculoskeletal injuries among Malaysian badminton players. Singapore Med J. 2009;50(11):1095-1097.
19. Rodriguez JO, Lavina AM, Agarwal A. Prevention and treatment of common eye injuries in sports. Am Fam Physician. 2003;67:1481-1488.