SCIENTIFIC JOURNAL OF SPORT AND PERFORMANCE

ORIGINAL ARTICLE

The role of gender and training age in shaping physical characteristics of volleyball players: A comparative analysis

Geeta Negi . *Department of Physical Education and Sports Sciences. University of Delhi. Delhi, India.*
Lalit Sharma. *Indira Gandhi Institute of Physical Education and Sports Sciences (IGIPESS). University of Delhi. Delhi, India.*
Meenakshi Singh. *Indira Gandhi Institute of Physical Education and Sports Sciences (IGIPESS). University of Delhi. Delhi, India.*
Komal Goel. *Department of Physical Education and Sports Sciences. University of Delhi. Delhi, India.*

ABSTRACT

High levels of athletics and fitness—including strength, power, speed, agility, coordination, and stamina—are necessary for volleyball. While power is needed for force generation, speed is needed for rapid movements, agility is needed for abrupt direction changes, coordination is needed for body control, and stamina is needed for sustained performance, strength is needed for high leaps and ball striking. A lack of these elements might provide difficulties for the sport. The physical characteristics of volleyball players who are male and female, as well as those who practice at different ages, were compared in this study. A minimum of one year of training age was required for the selection of 312 players from Delhi, of which 144 were female and 168 were male. To evaluate differences, a two-way MANOVA was employed. With more type 2 muscular fibers, longer legs, and larger muscles, male athletes had an edge in speed, core strength, and leg muscle endurance. Performance in these areas was also influenced by years of training. The athletes that played the most got the highest results in terms of arm, core, leg muscular endurance and speed as well as reaction time. The overall score of the participants was impacted by the fact that male players advanced the fastest, while female players gained more gradually.

Keywords: Performance analysis, Sports training, Volleyball performance, Physical attributes.

Cite this article as:
Negi, G., Sharma, L., Singh, M., & Goel, K. (2024). The role of gender and training age in shaping physical characteristics of volleyball players: A comparative analysis. *Scientific Journal of Sport and Performance*, *3*(3), 333-350. https://doi.org/10.55860/NJQT6791

Corresponding author. *Department of Physical Education and Sports Sciences. University of Delhi. Delhi, India.*
E-mail: negigeeta.gn@gmail.com
Submitted for publication February 24, 2024.
Accepted for publication April 16, 2024.
Published April 23, 2024.
Scientific Journal of Sport and Performance. ISSN 2794-0586.

doi: https://doi.org/10.55860/NJQT6791

INTRODUCTION

High-level competition efficiency necessitates optimal motor abilities, heart function, and maximum oxygen intake, which vary by sport and should be tailored to the activity's specific requirements (Sporis et al., 2010). Skill-related fitness helps athletes stay in shape and improve stamina for competition to reach higher level of performance. They must be in peak physical condition for their chosen sport in order to compete. Athlete phenomenon testing is a popular endeavour that focuses on a variety of factors influencing performance. Examples include physical, psychological, social, and scientific training, as well as a healthy physique, anatomy, body composition, endurance, flexibility, response time, coordination, agility, speed, strength, and body balance (Mondal, Nayek & Chatterjee, 2016).

Volleyball is a small-court sport in which participants sprint and jump vertically. They serve, pass, set the ball, spike, and attack while performing rapid vertical jumping and landing. To keep the ball from hitting the ground, the sport requires agility and rapid reaction time (Kim & Jeoung, 2016; Fattahi et al., 2012). Motor skills, consistency in training, motivation, and physiological factors all contribute to volleyball athletes' performance (Nasuka et al., 2020). Volleyball requires a high degree of athleticism and fitness, including crucial components like strength, power, speed, agility, coordination, and stamina. Strength is necessary for high jumps and ball striking, while power is required for force generation, speed for fast movement, agility for quick direction changes, coordination for body control, and stamina for long-term performance. Lack of these components may provide challenges in the sport (Darrel, 2022). Both physical condition and kinanthropometric factors have an important role in performance.

Men and women are physiologically different. Men have comparatively stronger- larger body with wider bones- muscle mass. These differences are also seen in volleyball. Sterkowicz et al., (2014) study examined the correlation between age, body height, body mass, BMI, and fitness test scores in Olympic volleyball tournament participants, the study revealed that skill level and gender influence attack and block jump. Albaladejo et al. (2022) suggested that early-stage categorization should be considered, as in his study statistical differences between male and female volleyball players in age, maturity offset, and age at peak height velocity (APHV) in a study of 96 adolescent volleyball players were found. Male players outperformed female players in terms of bone and muscle-related characteristics, as well as strength and power production-related physical tests. These discrepancies were significantly influenced by age and biological maturity, indicating that early-stage categorization should be considered.

Regular training begins in childhood and increases fitness and motor function while also instilling personal characteristics such as effort, persistence, dedication, and a drive to persevere and accomplish tasks. These characteristics are thought to predict physical activity adherence, making it a part of the lifestyle of individuals willing to put forth effort, determination, and diligence in their pursuit of physical activity (Xabilin et al., 2016; Layar & Lanties, 2018; Annesi, 2004 as cited in Kutac et al., 2023). K. Anders Ericsson, a Swedish psychologist, developed the purposeful practice theory in 1993, which explains differences in performance in sports, arts, sciences, and intellectual tasks as a result of accumulating hours of focused attention. More successful individuals have a lower BMI, are less mesomorphic and endomorphic, and are more ectomorphic than their less successful counterparts. They also possess greater lower body strength, speed, agility, and upper body strength (Milic et al., 2017). Soccer PRO players beat younger players in all parameters except sprint tests, most likely because to differences in training experience, technical skill, and individual strength/power levels, emphasizing the importance of specialized training measures (Kobal et al., 2016). Lorenz's work, as cited by Farley et al. (2020), emphasizes the importance of physical fitness testing in identifying top players and potential talent. Elite players in team-based ball and endurance sports have superior power due to their speed and agility. Anthropometric parameters such as height, weight, and body fat percentage are less sensitive in predicting future performance (Farley et al., 2020). Bidaurrazaga-Letona et al. (2016) investigated 528 young individuals (11.90.3 years) divided into four age groups and four training levels to determine the most critical anthropometric factors related with success and promotion to the top levels of youth football. Elite players were taller and lighter than the overall population, but they gained weight as they aged.

Keeping into consideration the gender differences and different training age the current study aimed at finding the difference between male and female volleyball players physical attributes. And also to assess differences among players with different training age. The traits chosen for the current study, which the author believes are crucial for a volleyball player to perform better are; Reaction time, Arm and Leg explosive strength, Agility, Speed, Arm, Cor and Leg muscular endurance.

METHODS

Subjects

Total of 312 (144 Female and 168 Male) volleyball players were selected for the study through purposive sampling from Delhi, with minimum of 1 years of training age. Age ranges from 11 to 23 years ((M = 16.43 ± 2.38 SD). Whereas Male player's mean age was ((M = 16.44 ± 2.34 SD), Female player's mean age was ((M = 16.44 ± 2.31 SD). The subjects further divided into 3 different categories.

Category I- players with training age of 1 to 2 years, N = 138 (M = 9, F = 45).
Category II- players with training age of 3 to 4 years, N = 106 (M = 60, F = 46).
Category III- players with training age of 5 years or onwards, N = 68, (M = 15, F = 53).

Measures

I.*Reaction Time*

Procedure: The person being tested stood near the edge of a table, with their elbow resting on the table and their wrist extending over the side. The assessor held the ruler vertically in the air between the subject's thumb and index finger, without touching the fingers, while aligning the zero mark with the subject's fingers. The subject was asked if he or she was ready. The tester abruptly released the ruler and let it fall; the subject had to catch it as soon as they saw it fall. Ruler's fall distance was measured in centimetres.
Scoring: To calculate the average distance, table mentioned below was used, which determine how long it took the ruler to fell the measured distance (distance in cm, time in seconds).

Table 1. Reaction time conversion chart.

Distance (cm)	Time (sec)	Distance (cm)	Time (sec)	Distance (cm)	Time (sec)
1	0.045	11	0.150	21	0.207
2	0.064	12	0.156	22	0.212
3	0.078	13	0.163	23	0.217
4	0.090	14	0.169	24	0.221
5	0.101	15	0.175	25	0.226
6	0.111	16	0.181	26	0.230
7	0.120	17	0.186	27	0.235
8	0.128	18	0.192	28	0.239
9	0.136	19	0.197	29	0.243
10	0.143	20	0.202	30	0.247

***II.**Upper Body explosive strength*

Procedure: The athlete sat on the floor with his legs fully extended and his feet 24 inches (60 cm) apart and the back against a wall. The ball was held with both hands on the sides, slightly behind the centre, and ball against the centre of the chest. The forearms were parallel to the ground. The athlete threw the medicine ball as far as he could while keeping his back to the wall. The thrown distance was measured.

Scoring: The distance from the wall to where the ball landed was measured. The measurement was taken to the nearest centimetre (other protocols have used the nearest 0.5 foot or 10 cm). The best of three throws was used to determine the final score.

***III.**Lower Body explosive strength*

Procedure: The athlete was instructed to stand sideways against a wall and reach up with the hand closest to the wall. The subject kept his feet flat on the ground, and the point of his fingertips was marked or recorded. As a result, the standing reach height was measured. The athlete then stood away from the wall and leaped vertically as high as possible, using both arms and legs to assist in projecting the body upwards. The subject was told to try to touch the wall at the highest point of the jump.

Scoring: The score was determined by the distance between the standing reach height and the jump height. The best of three tries was saved.

***IV.**Agility*

Procedure: A test was conducted where a subject ran through four cones. Cones were placed to form a T. Starting at cone A and then moving to cone B, then to cone C, then to cone D, and finally back to cone A. The timer stopped when the subject crossed cone A.

Scoring: 3 trials were given, shortest time was considered as score.

***V.**Speed*

Procedure: The procedure is to run a single maximum sprint over a 20 meters distance, with time recorded. On the command to go, the subject began running to the finish line, and attempted to cross it as quickly as possible. The timer stopped the stopwatch as soon as the subject crossed the end line.

Scoring: shortest time taken to complete the sprint was considered as final score from 3 trials.

***VI.**Arm and Shoulder muscular endurance*

Procedure: The subject began in a plank position, with his face down, forearms (palms facing down), and toes on the floor. The elbows were kept directly under the shoulders, and the forearms were facing forward. The subject then bent his elbows to get as close to the floor as possible while still squeezing his gluteus and core. The subject later pushed away from the floor to regain his original position. While pushing away, no back arching or bending was permitted. In modified push-ups, the female subject was instructed to maintain a half-plank position by keeping her knees bent on the floor and then do push-ups in that altered position.

Scoring: The maximum number of correctly performed push- ups in one minute was used to calculate the score.

***VII.**Core muscular endurance*

Procedure: The subject was instructed to lie face-up on the floor by the tester. To bend his knees so his feet were flat on the floor. The subject was able to keep his feet firmly held with the assistance of his partner. Subject was instructed to place his hands behind his head, fingers interlocked. The subject was instructed to lift his back off the ground with his abdominal muscles until his hands touched his knees, then return to the floor without jerking.

Scoring: The total number of correctly performed sit-ups in 1 minute was recorded.

VIII.*Leg muscular endurance*

Procedure: The expert explained and demonstrated the proper squat position. Feet shouldered shoulder length apart, hands behind the neck or extended forward parallel to the ground, whichever felt more comfortable. The subject was directed to maintain his\her back straight and bend their knees at a 90-degree angle until their thighs were parallel to the floor. That's one more time.

Scoring: The subject had one minute to perform as many squats as possible. Only correct posture was counted, and the number of correct squats performed was used to calculate the subject's score.

Statistical analysis

Standard descriptive statistics (mean & standard deviation) were calculated. For data comparisons and interactions between male- female volleyball players and among different training age categories, two-way multivariate analysis of variance (MANOVA) was used, followed by a post hoc Bonferroni test. SPSS (Statistical Package for Social Science) version 22.0 was used. The degree of probability chosen to establish statistical significance was 5%.

RESULTS

The mean score of Reaction time for male volleyball players with training age of 1 to 2 years is M = 0.18 ± 0.03, for male players with training age of 3 to 4 years is M = 0.17 ± 0.03 and for male player with training age of 5 years onwards is M = 0.16 ± 0.02. Whereas, in female volleyball players with training age of 1 to 2 years, the mean value for reaction time is M = 0.18 ± 0.03, for players with training age of 3 to 4 years is M = 0.17 ± 0.02 and for women players with training age of 5 years onwards is .17 ± 0.02.

The mean score of arm explosive strength for male volleyball players with training age of 1 to 2 years is M = 4.63 ± 0.96, for male players with training age of 3 to 4 years is M = 4.93 ± 0.87 and for male player with training age of 5 years onwards is M = 5.26 ± 0.66. Whereas, in female volleyball players mean score of arm explosive strength with training age of 1 to 2 years is M = 3.53 ± 0.58, for female players with training age of 3 to 4 years is M = 4.06 ± 0.52 and for women players with training age of 5 years onwards is 3.84 ± 0.59.

The mean score of Leg explosive strength for male volleyball players with training age of 1 to 2 years is M = 45.24 ± 9.35, for male players with training age of 3 to 4 years is M = 50.35 ± 8.07 and for male player with training age of 5 years onwards is M = 53.53 ± 7.85. Whereas, in female volleyball players mean score of vertical jumps with training age of 1 to 2 years is M = 31.59 ± 5.7, for female players with training age of 3 to 4 years is M = 36.13 ± 6.24 and for women players with training age of 5 years onwards is 36.24 ± 4.98.

The mean score of Agility for male volleyball players with training age of 1 to 2 years is M = 11.33 ± 1.15, for male players with training age of 3 to 4 years is M = 10.83 ± 0.80 and for male player with training age of 5 years onwards is M = 10.42 ± 0.55. Whereas, in female volleyball players mean score of agility with training age of 1 to 2 years is M = 13.00 ± 1.03, for female players with training age of 3 to 4 years is M = 12.38 ± 0.93 and for female players with training age of 5 years onwards is 12.29 ± 1.10.

The mean score of Speed for male volleyball players with training age of 1 to 2 years is M = 3.67 ± 0.33, for male players with training age of 3 to 4 years is M = 3.53 ± 0.30 and for male player with training age of 5 years onwards is M = 3.55 ± 0.26. Whereas, in female volleyball players mean score for speed in athletes with training age of 1 to 2 years is M = 4.08 ± 0.31, for female players with training age of 3 to 4 years is M = 3.9 ± 0.41 and for women players with training age of 5 years onwards is 3.9 ± 0.33.

Table 2. Descriptive statistics of physical attributes of male and female volleyball players belonging to different age group.

Variables	Gender	Training age	N	Mean	SD
Reaction time	Male	1- 2 years	93	.18	.03
		3-4 years	60	.17	.03
		5 years onwards	15	.16	.02
		Total	168	.18	.03
	Female	1- 2 years	45	.18	.03
		3-4 years	46	.17	.02
		5 years onwards	53	.17	.02
		Total	144	.18	.02
Upper body explosive strength	Male	1- 2 years	93	4.63	.96
		3-4 years	60	4.93	.87
		5 years onwards	15	5.26	.66
		Total	168	4.79	.92
	Female	1- 2 years	45	3.53	.58
		3-4 years	46	3.87	.54
		5 years onwards	53	4.06	.52
		Total	144	3.84	.59
Lower body explosive strength	Male	1- 2 years	93	45.24	9.35
		3-4 years	60	50.35	8.07
		5 years onwards	15	53.53	7.85
		Total	168	47.8	9.23
	Female	1- 2 years	45	31.59	5.7
		3-4 years	46	63.13	6.24
		5 years onwards	53	36.24	4.98
		Total	144	34.75	5.99
Agility	Male	1- 2 years	93	11.33	1.15
		3-4 years	60	10.83	.80
		5 years onwards	15	10.42	.55
		Total	168	11.07	1.04
	Female	1- 2 years	45	13.00	1.03
		3-4 years	46	12.38	.93
		5 years onwards	53	12.29	1.10
		Total	144	12.54	1.06
Speed	Male	1- 2 years	93	3.67	.33
		3-4 years	60	3.53	.30
		5 years onwards	15	3.55	.26
		Total	168	3.61	.32
	Female	1- 2 years	45	4.08	.31
		3-4 years	46	3.9	.41
		5 years onwards	53	3.9	.33
		Total	144	3.96	.36
Arm muscular endurance	Male	1- 2 years	93	26.52	10.45
		3-4 years	60	29.98	10.17
		5 years onwards	15	35	8.12
		Total	168	28.51	10.44

	Female	1- 2 years	45	25.78	9.57
		3-4 years	46	29.85	10.11
		5 years onwards	53	29.53	10.64
		Total	144	28.46	10.24
Core muscular endurance	Male	1- 2 years	93	31.23	7.43
		3-4 years	60	31.55	6.06
		5 years onwards	15	35.13	8.57
		Total	168	31.69	7.13
	Female	1- 2 years	45	24.82	8.91
		3-4 years	46	30.72	5.95
		5 years onwards	53	32.38	7.10
		Total	144	29.49	8.02
Leg muscular endurance	Male	1- 2 years	93	40.94	8.41
		3-4 years	60	47.95	8.10
		5 years onwards	15	45.6	4.48
		Total	168	41.71	8.10
	Female	1- 2 years	45	36.71	7.81
		3-4 years	46	40.63	7.6
		5 years onwards	53	40.87	8.75
		Total	144	39.49	8.27

The mean score of Arm Muscular Endurance for male volleyball players with training age of 1 to 2 years is M = 26.52 ± 10.45, for male players with training age of 3 to 4 years is M = 29.98 ± 10.17 and for male player with training age of 5 years onwards is M = 35.00 ± 8.12. Whereas, in female volleyball players mean score of Arm Muscular Endurance with training age of 1 to 2 years is M = 25.78 ± 9.57, for female players with training age of 3 to 4 years is M = 29.85 ± 10.11 and for women players with training age of 5 years onwards is 29.00 ± 10.24.

The mean score of Core Muscular Endurance for male volleyball players with training age of 1 to 2 years is M = 31.23 ± 7.43, for male players with training age of 3 to 4 years is M = 31.55 ± 6.06 and for male player with training age of 5 years onwards is M = 35.13 ± 8.57. Whereas, in female volleyball players mean score of Core Muscular Endurance with training age of 1 to 2 years is M = 25.11 ± 8.91, for female players with training age of 3 to 4 years is M = 30.72 ± 5.95 and for women players with training age of 5 years onwards is 32.38 ± 7.1.

The mean score of Leg Muscular Endurance for male volleyball players with training age of 1 to 2 years is M = 40.97 ± 8.41, for male players with training age of 3 to 4 years is M = 41.78 ± 8.10 and for male player with training age of 5 years onwards is M = 45.6 ± 4.49. Whereas, in female volleyball players mean score of Leg Muscular Endurance with training age of 1 to 2 years is M = 36.53 ± 7.81, for female players with training age of 3 to 4 years is M = 40.63 ± 7.6 and for women players with training age of 5 years onwards is 40.87 ± 8.75.

Table 3. Pillai's Trace Test.

Variable	**F**	***p*-value**	**Partial eta squared**
Gender	39	.00	.51
Training age	3.49	.00	.09
Gender training age	1.3	.19	.03

Note. Significance level .05.

On analysing Table 3, it is seen that the Pillai's trace value for gender is F = 39, *p* = .00, which is significant at .05 level. Hence the hypothesis that there will be no significant difference between gender is rejected, and it is concluded that there is a significant difference between male and female volleyball players in term of their physical attributes. The value for training age category is F = 3.49, *p* = .00, which is also found significant at .05 level. Hence the hypothesis is rejected and it is concluded that, there is a significant difference among different training age category in terms of physical attributes of volleyball players. But Pillai's trace value is insignificant for the interaction between gender and age category F = 1.3, *p* = .19. Hence we accept the hypothesis and conclude there is no significant difference between male and female volleyball player's physical attributes in context to their training age.

Table 4. Levene's Test of equality of error variance.

Variables	F	Df1	Df2	*p*-value
Reaction time	1.47	5	306	.198
Arm explosive strength	8.85	5	306	.00
Leg explosive strength	5.64	5	306	.00
Agility	2.67	5	306	.022
Speed	1.43	5	306	.21
Arm muscular endurance	.59	5	306	.71
Core muscular endurance	1.42	5	306	.22
Leg muscular endurance	1.05	5	306	.39

Note. Significance level .05.

From the Table 4, it can be observed that Levene's statistics for reaction time (f = 1.47, *p* = .198) is not significant at .05, indicating that there is no significant difference among the scores of reaction time of volleyball players, hence it is concluded that no heteroskedasticity is found in the score of reaction time score. The result indicates that reaction time data is suitable to be further operated by MANOVA.

Levene's statistics for upper body explosive strength (f = 8.85, *p* = .00) is significant at .05, indicating that there is a significant difference among the scores of upper body explosive strength of volleyball players, hence it is concluded that heteroskedasticity is present in the arm explosive strength score. The result indicates that upper body explosive strength data is not suitable to be further operated by MANOVA.

Levene's statistics for Leg explosive strength (f = 5.64, *p* = .00) is significant at .05, indicating that there is a significant difference among the scores of vertical jumps of volleyball players, hence it is concluded that heteroskedasticity is present in score of leg explosive strength score. The result indicates that lower body explosive strength data is not suitable to be further operated by MANOVA.

Levene's statistics for agility (f = 2.67, *p* = .02) is significant at .05, indicating that there is a significant difference among the scores of agilities of volleyball players, hence it is concluded that heteroskedasticity is present in score of agility score. The result indicates that agility data is not suitable to be further operated by MANOVA.

Levene's statistics for speed (f = 1.43, *p* = .21) is not significant at .05, indicating that there is no significant difference among the scores of speeds of volleyball players, hence it is concluded that no heteroskedasticity is found in the score of speed score. The result indicates that reaction speed data is suitable to be further operated by MANOVA.

Levene’s statistics for arm muscular endurance (f = 0.59, p = .71) is not significant at .05, indicating that there is no significant difference among the scores of arms muscular strength of volleyball players, hence it is concluded that no heteroskedasticity is found in the arm muscular strength score. The result of upper body muscular endurance indicates that reaction time data is suitable to be further operated by MANOVA.

Levene’s statistics for core muscular endurance (f = 1.42, p = .22) is not significant at .05, indicating that there is no significant difference among the scores of cores muscular strength of volleyball players, hence it is concluded that no heteroskedasticity is found in the core muscular strength score. The result indicates that core muscular endurance data is suitable to be further operated by MANOVA.

Levene’s statistics for leg muscular endurance (f = 1.05, p = .39) is not significant at .05, indicating that there is no significant difference among the scores of legs muscular strength of volleyball players, hence it is concluded that no heteroskedasticity is found in the leg muscular strength score. The result indicates that lower body muscular endurance data is suitable to be further operated by MANOVA.

Because Levene's test is significant for arm explosive strength, leg explosive strength, and agility, no further MANOVA will be conducted for these variables. Subsequent computations will be done to determine speed, response time, arm, core, and leg muscle endurance.

Table 5. Between subjects effects.

Source	Variable	df	Mean sq.	F	Sig.	Partial eta squared
Gender	Reaction time	1	.00	.73	.40	.00
	Speed	1	8.26	74.82	.00	.19
	Arm muscular endurance	1	301.12	3.01	.08	.00
	Core muscular endurance	1	612.06	12.32	.00	.04
	Leg muscular endurance	1	678.64	10.95	.00	.04
Training age	Reaction time	2	.005	8.43	.00	.052
	Speed	2	.814	7.38	.00	.05
	Arm muscular endurance	2	725.4	7.24	.00	.05
	Core muscular endurance	2	578.54	11.64	.00	.07
	Leg muscular endurance	2	386.22	6.23	.00	.04
Gender* training age	Reaction time	2	.001	1.12	.33	.00
	Speed	2	.02	.19	.83	.00
	Arm muscular endurance	2	154.14	1.51	.22	.01
	Core muscular endurance	2	207.22	4.17	.02	.03
	Leg muscular endurance	2	91.35	1.47	.23	.00

Note. Significance level .05.

Table 5 indicates that there is no significant difference between the male and female volleyball players reaction time score, as F value is not significant at .05 level, F (1, 306) = .73, p = .40, > .05. It is clearly seen that no statistical difference present in reaction time score of male and female.

Significant difference is found between male and female players Speed score, as F value is significant at .05 level, F (1, 306) = 74.82, p = .00, < .05. It is clearly seen that statistical difference is present in speed of male and female players.

No significant difference between the male and female volleyball players Arm muscular endurance score, as F value is not significant at .05 level, F (1, 306) = 3.01, p = .08, > .05. It is clearly seen that no statistical difference present in arm muscular endurance score of male and female.

Significant difference is found between male and female players Core muscular endurance score, as F value is significant at .05 level, F (1, 306) = 12.32, p = .00, < .05. It is clearly seen that statistical difference is present in core muscular endurance of male and female players.

Significant difference is found between male and female players Leg muscular endurance score, as F value is significant at .05 level, F (1, 306) = 10.95, p = .00, < .05. It is clearly seen that statistical difference is present in leg muscular endurance of male and female players.

Significant difference is found among the reaction time score of players belonging to three different training age categories, as F value is significant at .05 level, F (1, 306) = 8.43, p = .00, < .05. It is clearly seen that statistical difference is present in reaction time among all the three training age category.

Significant difference is found among the speed score of players belonging to three different training age categories, as F value is significant at .05 level, F (1, 306) = 7.38, p = .00, < .05. It is clearly seen that statistical difference is present in speed among all the three training age category.

Significant difference is found among the arm muscular endurance score of players belonging to three different training age categories, as F value is significant at .05 level, F (1, 306) 7.24, p = .00, < .05. It is clearly seen that statistical difference is present in arm muscular endurance among all the three training age categories.

Significant difference is found among the core muscular endurance score of players belonging to three different training age categories, as F value is significant at .05 level, F (1, 306) 11.64, p = .00, < .05. It is clearly seen that statistical difference is present in core muscular endurance among all the three training age categories.

Significant difference is found among the core muscular endurance score of players belonging to three different training age categories, as F value is significant at .05 level, F (1, 306) 6.24, p = .00, < .05. It is clearly seen that statistical difference is present in leg muscular endurance among all the three training age categories.

The result reveals a significant difference in reaction time of players belonging to training age level 1 to 2 years - 3 to 4 years (p = .01) and 1 to 2 years – 5 years onwards (p = .00), however, no significant difference is found between players belonging to training age of 3 to 4 years and 5 years onwards (p = 1.00).

A significant difference is found in speed of players belonging to training age level 1 to 2 years – 3 to 4 years (p = .03) and 3 to 4 Years – 5 years onwards (p = .04), however is insignificant in players belonging to training age level 1 to 2 years- 5 years onwards (p = 1.00).

A significant difference is found in arm muscular endurance of players belonging to training age 1 to 2 years – 3 to 4 years (p = .02) and 1 to 2 years – 5 years onwards (p = .00), however is insignificant in players belonging to 3 to 4 years – 5 years onwards (p = 1.00).

An insignificant difference is found in core muscular strength of players belonging to training age level 1 to 2 years – 3 to 4 years (*p* = .12), 1 to 2 years – 5 years onwards (*p* = 1.04) and 1 to 2 years – 5 years onwards (*p* = .31).

An insignificant difference is found in leg muscular strength of players belonging to training age level 1 to 2 years – 3 to 4 years (*p* = .25), 1 to 2 years – 5 years onwards (*p* = .12) and 1 to 2 years – 5 years onwards (*p* = 1.00).

Table 6. Post Hoc test of different physical attributes at different training age level.

Variables	**Training age**	**Mean diff**	**Std. error**	***p*-value**	**Confidence interval for diff**	
					Lower bound	**Upper bound**
Reaction time	(1 to 2 yrs.)- (3 to 4 yrs.)	.01	.00	.01	.00	.02
	(1 to 2 yrs.)- (5 yrs. onwards)	.01	.00	.00	.00	.02
	(3 to 4 yrs.)- (5 yrs. onwards)	.00	.00	1.00	-.00	.01
Speed	(1 to 2 yrs.)- (3 to 4 yrs.)	.11	.04	.03	.01	.21
	(1 to 2 yrs.)- (5 yrs. onwards)	-.02	.05	1.00	-.14	.10
	(3 to 4 yrs.)- (5 yrs. onwards)	.13	.05	.04	-.25	.25
Arm muscular endurance	(1 to 2 yrs.)- (3 to 4 yrs.)	-3.65	1.29	.02	-6.76	-.54
	(1 to 2 yrs.)- (5 yrs. onwards)	-4.05	1.48	.00	-7.62	-.48
	(3 to 4 yrs.)- (5 yrs. onwards)	.399	1.56	1.00	-3.35	4.14
Core muscular endurance	(1 to 2 yrs.)- (3 to 4 yrs.)	-1.89	.91	.12	-4.08	.30
	(1 to 2 yrs.)- (5 yrs. onwards)	-3.69	1.24	1.04	-6.2	-1.17
	(3 to 4 yrs.)- (5 yrs. onwards)	1.8	1.1	.31	-.84	4.43
Leg muscular endurance	(1 to 2 yrs.)- (3 to 4 yrs.)	-1.76	1.12	.25	-4.21	.69
	(1 to 2 yrs.)- (5 yrs. onwards)	-2.39	1.17	.12	-5.2	.42
	(3 to 4 yrs.)- (5 yrs. onwards)	.63	1.22	1.00	-2.32	3.58

Note. Significance level .05.

DISCUSSION

Reaction time

In volleyball, response time is critical in order to reach the ball on time, whether setting, receiving an attack, or blocking. Volleyball is a fast-paced game that needs players to move and react swiftly in order to execute all of the aforementioned skills successfully while also protecting and scoring points (Lipss et al., 2011; Spierer et al., 2010; Jain et al., 2015 and Noble et al., 1964) all found that gender differences exist in reaction time. According to Misra et al. (1985), the role of gender on RT demonstrates that in practically every age group, males have quicker RTs than females, and the female disadvantage is not alleviated by practice. Gender influences RT in practically every age group (Noble et al., 1964; Adam et al., 1999; Der and Deary, 2006). In support of this, Botwinick et al. (1966) stated in the literature that the male-female difference is attributable to the latency between stimulus presentation and muscle contraction initiation. To this, Silverman (1966) added that male and female have the same muscular contraction time, but males have greater motor responses than females. This explains why male have faster simple response times to both auditory and visual inputs. Jain, et al. (2015).

In contrast to the previous findings, the current study demonstrated no significant variation in reaction time between male and female volleyball players. In fact, both groups scored the same for reaction time. Similar outcomes were reported by Reaction time test (2023). The article mentioned Ellis et al. (2009)'s study, which evaluated simple response time, choice reaction time, and movement time in a sample of 269 people and showed no significant difference in reaction time between men and women. Similarly, Stumpf et al. (2018) observed no significant variation in reaction time between 51 male and 51 female individuals. Ferreira et al. (2017) observed no significant difference in response time between male and female Judo players, lending confirmation to the conclusions of this study.

In the current study, the reaction time of players aged 1 to 2 years differs considerably from those aged 3 to 4 years and 5 years and beyond. Players with more years of training age had the fastest reaction time compared to the other two categories, and with continuing practice, reaction speed improved. However, there was no significant difference in reaction time between participants aged 3 to 4 years and those aged 5 and beyond. Barcelos (2009) investigated motor reaction time in volleyball players of various ages and skill levels. He also discovered that the highly experienced athletes had a lower discriminating reaction time. The findings demonstrated a significant difference in reaction and discrimination time, indicating that more an athlete practices, the more it seems to encourage the development of the cognitive aspects of the practitioners. The non-significant difference in response time between groups belonging to training age of 3-4 and 5 years and onwards might be due to the fact that after players achieve a certain degree of proficiency, they are more focused on increasing game-related abilities rather than general skills. Therefore, their training sessions may be customized to work on game related skills rather than working general skills. It may also be considered that the progress occurs during the first four years of consistent practice; thereafter, it does not improve as much as it did in the early years of training. It is also likely that boredom sets in. According to Velasco and Jorda (2020), sportsmen typically experience boredom when performing repeated activities, as well as negative emotions, lack of desire, long wait periods, and a lack of competitiveness. This dullness has a significant impact on their performance and may lead to overconsumption. Athletes that are more prone to boredom prefer to buy different types of sports beverages and partake in overconsumption, indicating that boredom plays a significant influence in their performance.

Speed

According to Chatterjee and Laudato (2010), male physiology favours itself better to anaerobic strength events. According to the Mancha et al. study (2021), an athlete's sex influences strength output because males recruit type II fibres more widely and have a greater number of them. This anatomical variation is mostly responsible for athletes' strength and power production. Which is the primary element driving the sex discrepancy in sprint and acceleration abilities. The current study supports the prior findings. Male volleyball players were faster than female volleyball players. Male players were seen to have longer stridden and greater stride speeds. This discrepancy might be explained by Spiteri et al. (2013), who discovered that male athletes had considerably better lower body strength, vertical braking force and impulse application, knee and spine flexion, and hip abduction. Men have longer legs and more muscular mass, as well as a predominance of fast twitch muscle fibre, all of which combine to provide an ideal environment for explosive power, which in result produce faster speed.

Matthys et al. (2013) found that top young handball players outperformed non-elite players on speed tests. Kafkas et al. (2019) reported considerable progress in the 30 m sprint with additional days of training. As he assessed the yearly growth of biomotor features in collegiate volleyball players during a two-year training and competition cycle. The present study findings are consistent with the above-mentioned findings: players with more years of training had higher speed. A considerable difference exists between groups 1 and 2. This suggests that players who have been practicing for three to four years are speedier than those who have just been trained for one or two years. Groups 2 and 3 also differed significantly. Players who have been training for 5 years or more outperformed those who have just been practicing for 3 to 4 years. However there was no significant difference between groups 1 and 3, no significant difference was detected between players who had been playing for one to two years and those who had been practicing for five years or more. However, the speed mean score of players with 5 more years of practice improved with more days of practice, although it was not statistically significant.

Muscular endurance

Volleyball has been defined as an interval sport that has both anaerobic and aerobic components. In extended rallies or tournament play, players must bend, leap, and move thousands of times, requiring high physical endurance. It is one of the necessary characteristics for success in volleyball. Muscular strength and endurance, particularly in the upper and lower limbs, influence the outcome of a serve, pass, spike, and blocking (Nasuka et al., 2020). Muscular endurance is the ability of a muscle to contract repeatedly at submaximal intensity. Muscular endurance is essential for volleyball players to retain their attention and skill, as it allows them to continue their motions and effort throughout the game. It reduces tiredness and aids athletes in maintaining attention and technique. Increased muscular endurance improves agility and quickness, helping players to move around the court more swiftly and efficiently. This agility benefits defensive plays since it allows players to react faster and make better judgements. Muscular endurance also helps athletes maintain their energy levels, allowing them to control their breathing and energy expenditure. This keeps them awake and energized throughout the game, increasing the likelihood of successful moves.

In general, women are less fatigable than males for tasks of relative difficulty (Hunter, S.K., 2016; Billaut & Bishop, 2009; Kriswanto & Nopembri, 2023; Henry Halse, 2016). In, Henry Halse (2016) article he stated that, while men and women differ substantially in size and shape, women have superior muscle endurance than men because they exhaust more slowly. Women appear to be better able to manage muscular endurance tasks. He points out that women often consume fewer carbs to power their muscles than males. They use fat for energy in less intense situations because carbohydrate is harder to regenerate than fat. Using fat more than carbohydrate for energy means that a muscle will be less powerful but it won't run out of energy as quickly. The presence of slower-twitch fibres also benefits female performance since slower oxidative fibres and better oxidative capacity allow for increased endurance and recovery, emphasising gender differences in response to fatigue or muscular tetanus Haizlip et al., (2015). The current study assesses muscular endurance in the arm, core, and leg. And the findings did not entirely agree with the previous findings.

The majority of volleyball skills demand arm and shoulder strength to perform attacking and servicing skills on a regular basis. Effective repeated attack and service need considerable muscle endurance. The current study discovered no significant differences in male and female arm muscular endurance. Male players scored higher in arm muscle endurance. Nuzzo (2023) also reported no persistent sex differences in the number of repetitions done with weights ranging from 60 to 90% 1RM for bench press. However, the biceps curl produced varying effects. According to Hoeger et al. (1990), males did roughly 2-5 more repetitions than women with a load equivalent to 60% 1RM, however other researchers found that women performed approximately 13-16 more repetitions than men with the same load (Maughan, 1986; Miller, 1993).

Better core muscular strength endurance is associated with increased shoulder mobility/stability, whereas more dorsal trunk muscle chain strength endurance is associated with increased throwing velocity. Bauer (2022). The current study's findings show a significant difference in male and female players' core muscular endurance. Males had greater scores for core muscular endurance. In contrast to the preceding study, Nuzzo, 2023 observed that women do more repetitions than men on the latissimus pulldown with weights ranging from 40 to 80% 1RM.

The current study's findings demonstrate a considerable difference in male and female players' leg muscle endurance. Males had greater scores for leg muscle endurance. For the leg press, Peiffer et al. (2010) found that males did more repetitions than women with weights equal to 70% 1RM, whereas Hoeger et al. (1990) found that women performed more repetitions than men with loads equal to 40% and 60% 1RM. For the knee extension exercise, there is either no gender difference or males can execute more repetitions than women (Nuzzo, 2023).

To test arm, core, and leg muscular endurance, athletes completed one minute of push-ups, sit-ups, and squats. Time might also be considered as a factor for contrasting outcomes. Because of the time aspect, players needed to increase their intensity and focus on their higher to maximum intensity. As males are equipped with more muscle mass and fast twitch muscle fibre, they performed better in all three muscular endurance components. As a consequence, either male players had greater physical endurance or there was no difference between the two sexes.

In the current study, it was shown that players with more years of training age performed better in arm muscular endurance than players with less years of training. There is a considerable difference in arm muscle endurance between groups one and two. This suggests that players between the training ages of 3 and 4 scored higher in arm muscular strength than those had training age of 1 to 2 years. Similarly, there is a substantial difference in arm muscle endurance between groups 1 and 3. This suggests that athletes in training for 5 years or more outperformed those in training for 1-2 years in terms of arm muscle endurance. There was no significant change in arm muscle endurance between groups 2 and 3. However, group 3 has a higher mean score in arm muscular endurance than group 2, but the difference is not statistically significant. Simply put, the arm muscular endurance scores of players with training age of 5 and beyond did not improve considerably when compared to those playing from last 3-4 years.

The current investigation found no significant difference in core muscular endurance between groups 1 and 2. This suggests that players with training age of 3 and 4 did not differ significantly from players with training age of 1 to 2 years. No significant difference in core muscular endurance between groups 1 and 3. This suggests that players with training age of 5 or more years did not score substantially higher in core muscular endurance than those with training age of 1–2 years. There is no substantial difference in core muscle endurance between groups 2 and 3. However, group 3 has a higher mean score in core muscular endurance than group 2, but the difference is not statistically significant. Simply put, the core muscular endurance scores of players with training age of 5 and beyond did not increase considerably compared to those with training age of 3-4 years.

The current investigation found no significant difference in leg muscle endurance between groups 1 and 2. This suggests that players with the training age of 3 and 4 years old performed much better in leg muscle endurance than players with training age of 1 to 2 years old. The current investigation found no significant difference in leg muscle endurance in groups with training age of 1 and 3. This suggests that players with training age of 5 and up did not score substantially higher in leg muscle endurance than those with training age of 1–2 years. There is no significant change in leg muscle endurance between groups 2 and 3. However, group 3 has a higher mean score in leg muscular endurance than group 2, but the difference is not statistically significant. Simply put, players aged with training age of 5 and more showed no significant improvement in leg muscle endurance compared to those with training age of 3-4 years.

In terms of core muscular endurance, it is possible that coaches did not adequately include core and strengthening activities. One possible explanation for that is core muscle endurance does not immediately increase volleyball performance. However, it indirectly improves players' offensive performance. It has also been observed that male players' core and leg muscle endurance increased better with longer periods of training than female players. Female players did not exhibit major improvements in core and leg muscle endurance with increasing training frequency. Because the cumulative score of male and female volleyball players was taken into account for the outcome, a low score for women had an influence on the total score.

It may be considered that the highest growth phase for players is the first three to four years of training, after which all improvement occurs gradually. The key to effective training is finding the right combination of workout time and intensity. Whether an athlete is an Olympian or a beginner, two criteria govern a workout: time and intensity. In the early years, athletes discover that increasing training durations and volume enhances their performance. To attain greater outcomes, training must be done within one's physical, mental, and temporal limits. They improve their speed simply by training for longer periods of time or covering more miles/kilometres. In reality, the pace of performance increase at this point is rather rapid. Increased length is unquestionably useful in the early years of a sport. Increasing weekly volume is not a successful strategy since the return on investment may stagnate or even drop. For elite athletes, beginning in the fourth year of serious training, the emphasis should move to intensity. This adjustment can sustain a strong positive performance slope for a few more seasons (Joe Friel, 2018).

CONCLUSION

Male and females differ in terms of speed, core strength, and leg muscle endurance. Male athletes were shown to have an advantage on the majority of the factors. Having more type 2 muscular fibres, longer legs, and bigger muscles helps them perform better in speed events. Male players also lead in terms of core and leg muscle endurance. Years of training also have an impact on performance in these factors. Players with the most playing time had the best scores in speed, reaction time, arm, core, and leg physical endurance. Male players progressed the most, whereas female players improved more gradually. This had an influence on the total score of the participants.

AUTHOR CONTRIBUTIONS

Geeta Negi (corresponding author): study design, data collection, manuscript preparation, statistical analysis. Prof. Dr. Lalit Sharma; study design, conceptualization. Dr. Meenakshi Singh: statistical analysis. Komal: manuscript preparation, data collection.

SUPPORTING AGENCIES

No funding agencies were reported by the authors.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

REFERENCES

Adam, J. J. (1999). Gender differences in choice reaction time: evidence for differential strategies. Ergonomics, 42(2), 327-335. https://doi.org/10.1080/001401399185685

Albaladejo-Saura, M., Vaquero-Cristóbal, R., García-Roca, J. A., & Esparza-Ros, F. (2022). The effect of age, biological maturation and birth quartile in the kinanthropometric and physical fitness differences between male and female adolescent volleyball players. Children, 9(1), 58. https://doi.org/10.3390/children9010058

Barcelos, J. L., Morales, A. P., Maciel, R. N., Azevedo, M. M. D. A., & da Silva, V. F. (2009). Time of practice: a comparative study of the motor reaction time among volleyball players. Fitness & Performance Journal (Online Edition), 8(2). https://doi.org/10.3900/fpj.8.2.103.e

Bauer, J., Gruber, M., & Muehlbauer, T. (2022). Correlations between core muscle strength endurance and upper-extremity performance in adolescent male sub-elite handball players. Frontiers in Sports and Active Living, 4, 1050279. https://doi.org/10.3389/fspor.2022.1050279

Bidaurrazaga-Letona, I., Zubero, J., Lekue, J. A., Amado, M., & Gil, S. M. (2016). Anthropometry and somatotype of pre-adolescent soccer players: Comparisons amongst elite, sub-elite and non-elite players with non-players. Collegium Antropologicum, 40(4), 269-277.

Billaut, F., & Bishop, D. (2009). Muscle fatigue in males and females during multiple-sprint exercise. Sports medicine, 39, 257-278. https://doi.org/10.2165/00007256-200939040-00001

Botwinick, J., & Thompson, L. W. (1966). Components of reaction time in relation to age and sex. The Journal of genetic psychology, 108(2), 175-183. https://doi.org/10.1080/00221325.1966.10532776

Darrel. (2022). The Different Fitness Components of Volleyball. https://vanguardvolleyball.com/

Darrel. (2023). Speed Is The Key To Volleyball Success: Boost Your Game With Speed And Dominate The Court!. https://vanguardvolleyball.com/

Der, G., & Deary, I. J. (2006). Age and sex differences in reaction time in adulthood: results from the United Kingdom Health and Lifestyle Survey. Psychology and aging, 21(1), 62. https://doi.org/10.1037/0882-7974.21.1.62

Fattahi, A., Ameli, M., Sadeghi, H., & Mahmoodi, B. (2012). Relationship between anthropometric parameters with vertical jump in male elite volleyball players due to game's position. Journal of human sport and Exercise, 7(3), 714-726. https://doi.org/10.4100/jhse.2012.73.11

Farley, J. B., Stein, J., Keogh, J. W., Woods, C. T., & Milne, N. (2020). The relationship between physical fitness qualities and sport-specific technical skills in female, team-based ball players: A systematic review. Sports medicine-open, 6(1), 1-20. https://doi.org/10.1186/s40798-020-00245-y

Friel, J. (n.d.). Duration and Intensity in Training. joefrieltraining.com. Retrieved from [Accessed, April 16, 2024]: https://joefrieltraining.com/duration-and-intensity-in-training/

Gangey, O., & Kerketta, I. (2006). Relationship between selected motor fitness and playing ability of volleyball players. Sciences, 29(1), 6-11.)

Gil, S. (2007). Selection of young soccer players in terms of anthropometric and physiological factors. The Journal of Sports Medicine and Physical Fitness,47(1), 25- 32.

Haizlip, K. M., Harrison, B. C., & Leinwand, L. A. (2015). Sex-based differences in skeletal muscle kinetics and fiber-type composition. Physiology, 30(1), 30-39. https://doi.org/10.1152/physiol.00024.2014

Hunter, S. K. (2016). Sex differences in fatigability of dynamic contractions. Experimental physiology, 101(2), 250-255. https://doi.org/10.1113/EP085370

Hoeger, W. W., Hopkins, D. R., Barette, S. L., & Hale, D. F. (1990). Relationship between repetitions and selected percentages of one repetition maximum: a comparison between untrained and trained males and females. The Journal of Strength & Conditioning Research, 4(2), 47-54. https://doi.org/10.1519/00124278-199005000-00004

Jain, A., Bansal, R., Kumar, A., & Singh, K. D. (2015). A comparative study of visual and auditory reaction times on the basis of gender and physical activity levels of medical first year students. International Journal of Applied and Basic Medical Research, 5(2), 124. https://doi.org/10.4103/2229-516X.157168

Jones, M. T., & Lorenzo, D. C. (2013). Assessment of power, speed, and agility in athletic, preadolescent youth. J Sports Med Phys Fitness, 53(6), 693-700.

Kafkas, A. Ş., Çinarli, F. S., & Kafkas, M. E. (2019). The longitudinal development of endurance, sprint, agility, strength and jumping performance within college volleyball players. Journal of Athletic Performance and Nutrition, 5(2).

Kim, C. G., & Jeoung, B. J. (2016). Assessment of isokinetic muscle function in Korea male volleyball athletes. Journal of exercise rehabilitation, 12(5), 429. https://doi.org/10.12965/jer.1632710.355

Kobal, R., Loturco, I., Gil, S., Cavinato Cal Abad, C., Cuniyochi, R., Barroso, R., & Tricoli, V. (2016). Comparison of physical performance among Brazilian elite soccer players of different age-categories. J Sports Med Phys Fitness, 56(4), 376-382.

Kriswanto, E. S., & Nopembri, S. (2023). Muscular Endurance and Strength as Predominant Factors on Spike among Young Volleyball Athletes. Retos: Nuevas Perspectivas de Educación Física, Deporte y Recreación, 50. https://doi.org/10.47197/retos.v50.99647

Kumar, H. S., & Kumar, S. T. (2018). Relationship of muscle strength muscle endurance and explosive power with playing ability of intercollegiate volleyball players. Asian Journal of Multidimensional Research (AJMR), 7(2), 257-260.

Kutáč, P., Zahradnik, D., Krajcigr, M., & Bunc, V. (2020). The effect of long-term volleyball training on the level of somatic parameters of female volleyball players in various age ategories. PeerJ, 8, e9992. https://doi.org/10.7717/peerj.9992

Mancha-Triguero, D., García-Rubio, J., Gamonales, J. M., & Ibáñez, S. J. (2021). Strength and speed profiles based on age and sex differences in young basketball players. International Journal of Environmental Research and Public Health, 18(2), 643. https://doi.org/10.3390/ijerph18020643

Matthys, S. P., Vaeyens, R., Fransen, J., Deprez, D., Pion, J., Vandendriessche, J., ... & Philippaerts, R. (2013). A longitudinal study of multidimensional performance characteristics related to physical capacities in youth handball. Journal of sports sciences, 31(3), 325-334. https://doi.org/10.1080/02640414.2012.733819

Maughan, R. J., Harmon, M., Leiper, J. B., Sale, D., & Delman, A. (1986). Endurance capacity of untrained males and females in isometric and dynamic muscular contractions. European journal of applied physiology and occupational physiology, 55, 395-400. https://doi.org/10.1007/BF00422739

Milić, M., Grgantov, Z., Chamari, K., Ardigò, L. P., Bianco, A., & Padulo, J. (2017). Anthropometric and physical characteristics allow differentiation of young female volleyball players according to playing position and level of expertise. Biology of sport, 34(1), 19-26. https://doi.org/10.5114/biolsport.2017.63382

Miller, A. E. J., MacDougall, J. D., Tarnopolsky, M. A., & Sale, D. G. (1993). Gender differences in strength and muscle fiber characteristics. European journal of applied physiology and occupational physiology, 66, 254-262. https://doi.org/10.1007/BF00235103

Misra, N., Mahajan, K. K., & Maini, B. K. (1885). Comparative study of visual and auditory reaction time of hands and feet in males and females. Ind J Physiol P'larmac, 29, 214-7.

Mondal, S., Nayek, B., & Chatterjee, K. (2016). A comparative study on strength, agility and dynamic balances between volleyball and basketball players. International Journal of Physiology, Nutrition and Physical Education, 1(2), 81-84.

Nasuka, N., Setiowati, A., & Indrawati, F. (2020). Power, strength and endurance of volleyball athlete among different competition levels. Utopía y Praxis Latinoamericana, 25(10), 15-23.

Noble, C. E., Baker, B. L., & Jones, T. A. (1964). Age and sex parameters in psychomotor learning. Perceptual and Motor skills, 19(3), 935-945. https://doi.org/10.2466/pms.1964.19.3.935

Nuzzo, J. L. (2022). Narrative review of sex differences in muscle strength, endurance, activation, size, fiber type, and strength training participation rates, preferences, motivations, injuries, and neuromuscular adaptations. The Journal of Strength & Conditioning Research, 10-1519. https://doi.org/10.1519/JSC.0000000000004329

Peiffer, J. J., Galvão, D. A., Gibbs, Z., Smith, K., Turner, D., Foster, J., ... & Newton, R. U. (2010). Strength and functional characteristics of men and women 65 years and older. Rejuvenation Research, 13(1), 75-82. https://doi.org/10.1089/rej.2009.0916

Silverman, I. W. (2006). Sex differences in simple visual reaction time: A historical meta-analysis. Sex roles, 54, 57-68. https://doi.org/10.1007/s11199-006-8869-6

Spiteri, T., Hart, N. H., & Nimphius, S. (2014). Offensive and defensive agility: a sex comparison of lower body kinematics and ground reaction forces. Journal of Applied Biomechanics, 30(4), 514-520. https://doi.org/10.1123/jab.2013-0259

Spierer, D. K., Petersen, R. A., Duffy, K., Corcoran, B. M., & Rawls-Martin, T. (2010). Gender influence on response time to sensory stimuli. The Journal of Strength & Conditioning Research, 24(4), 957-963. https://doi.org/10.1519/JSC.0b013e3181c7c536

Sporiš, G., Milanović, L., Jukić, I., Omrčen, D., & Sampedro Molinuevo, J. (2010). The effect of agility training on athletic power performance. Kinesiology, 42(1.), 65-72.

Sterkowicz-Przybycień, K., Sterkowicz, S., & Żak, S. (2014). Sport skill level and gender with relation to age, physical development and special fitness of the participants of Olympic volleyball tournament Beijing 2008. Collegium antropologicum, 38(2), 511-516.

Tavares, F., Mendes, B., Driller, M., & Freitas, S. (2017). Do young elite football athletes have the same strength and power characteristics as senior athletes? Journal of Functional Morphology and Kinesiology, 2(4), 48. https://doi.org/10.3390/jfmk2040048

Velasco, F., & Jorda, R. (2020). Portrait of boredom among athletes and its implications in sports management: a multi-method approach. Frontiers in psychology, 11, 831. https://doi.org/10.3389/fpsyg.2020.00831