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Original Article

Fitness Profile of Male Swimmers and Water Polo Players of Kolkata, India – a Comparative Study

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Abstract

Introduction: Present study was aimed to evaluate the important fitness profile parameters in young male Indian Water Polo players and swimmers.

Materials & Methods: State level male Water Polo players (age: 22.73±1.91 yrs) and swimmers (age: 22.00±1.13 yrs) were recruited from different sports academies, Kolkata, India. Sedentary subjects (age: 24.50±1.91 yrs) were randomly sampled from the same area. Physical and fitness profile parameters were assessed by standard methods.

Results: VO_{2max}, high intensity effort and agility depicted significantly ($p<0.05$) higher values in Water Polo group while flexibility, vertical jump test (VJT) and push up exhibited significantly ($p<0.05$) higher values in swimmers. Higher agility score in Water Polo might be attributed to their body movements from a horizontal to a vertical position. Higher score of flexibility, VJT and push up in swimmers was probably due to their participation in dynamic stretching, plyometric activities and specific motor pattern movements as well as breaststroke swimming. This indicated the tendency of having higher anaerobic capabilities in Swimmers in comparison to their Water Polo counterparts.

Conclusion: Water Polo players and Swimmers have significant difference in the fitness profile parameters due to the variation in their event specific activity and difference in the training pattern. These data would also serve as the National standard of fitness profile data in Indian context.

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Introduction

Water Polo is a physically demanding and complex sport, composed of high power bursts of sprinting, interspersed with short time of low to moderate intensity swimming (1, 2). The game possesses a number of substantial physiological twists on both the aerobic and anaerobic metabolic pathways (2). Both the events involve all the three energy systems, i.e., anaerobic ATP-CP, anaerobic glycolysis and aerobic system in different proportion. The contribution of these three energy systems in case of Water Polo is 30%, 40% and 30%, respectively (3). On the other hand, the relative contribution of these energy systems in case of long distance swimming is 10%, 20% and 70% while in case of short distance swimming (50 m free style) is 90% anaerobic glycolysis and 10% aerobic system, respectively (4).

The uniqueness of Water Polo requires satisfactory conditioning, involving both specific motor skills and practical abilities (1). During the game, Water Polo players play in two basic swimming postures – the horizontal or the vertical one – from which they apprehend various technical and tactical actions (1).

Swimming is one of the largest Olympic sports with 16 pool events. Competitive Swimmers have particular anthropometric characters compared with other athletes because of their physiological adaptations to enhance their performance (5). Swimmers undergo large volume of training in the water pool as well as on the dry land (5). Both dry-land and in-water specific strength training of male Water Polo players improved the score of most Water Polo-specific performance parameters (6).

Strength training, leg-kick training, aerobic and anaerobic swimming training are broadly used for Swimmers while the training for the improvement of motor fitness, functional ability and cardiorespiratory system are also of prime importance in case of both Swimming and Water Polo (5, 7). The average heart rate of male Water Polo players during the match is 80% of their HR_{max} (8). Middle distance swimming requires high VO_{2max}, although with the further increase in the swimming distance the requirement of high VO_{2max} decreases (4). Water Polo imposes tremendous physical and physiological demand on athletes since it is a high intensity intermittent activity interspersed with aggressive physical contact with opponent player (6). Male Water Polo players are balanced mesomorphs with heavier body and higher fat percentage (9). Elite Water Polo players spend the 86% of the match play at 82% of their HRmax that is lower than the intensity that corresponds to the lactate threshold (9).

Fitness profile of Swimmers and Water Polo players have been reported from different countries (1-7). Limited data of fitness profile in Indian Swimmers is available (10). But similar data of Swimmers and Water Polo players from Eastern part of India are unavailable. To our knowledge, only one comparative study between these two aquatic sports was conducted in Israeli population (7) and such comparative study is unavailable in Indian context. The present study was therefore aimed to evaluate the fitness profile parameters in young male Eastern Indian swimmers and Water Polo players and also to compare the data not only between these two athletic groups but also with their sedentary and overseas counterparts. Further comparison of the data obtained in Swimmers and Water Polo players with their sedentary control counterparts would depict the extent of beneficial effects of the corresponding training on the studied parameters.

Materials & Methods

State level Swimmers (n=30, age: 22.71±1.23 yrs) and Water Polo players (n=30, age: 22.36±1.22 yrs) with at least five years of regular involvement in training were recruited in the study from different Swimming and Water Polo academies of Kolkata, India. Sedentary (n=30) control subjects (age: 22.79±1.32 yrs) with same age range (range 20–25 yrs) and same socio-economic conditions (11) were recruited by simple random sampling from the similar localities where the Swimmers and Water Polo players lived. Subjects were neither suffering from any disease nor under any medication during the study time. They had no record of major diseases, bone fracture or injury. The sample size was calculated using the method of Das and Das (1998) where the input of confidence interval was set as 95%. The sample size was greater than computed sample size of twenty-seven in each group (12). The study was carried out at temperature ranging between 20–23°C and relative humidity ranging between

40–45%. Ethical clearance was obtained from the Human Ethics Committee of the Department of Physiology, University of Calcutta and written informed consent was obtained from all the subjects.

Each subject arrived at the laboratory for three days with a gap of at least 7 days in between two consecutive days of visit. They reported in the laboratory at 9 am in all the visits. Familiarisation trial was conducted on the first visit when they were described and were demonstrated all the experiments to allay apprehension. After that they were familiarised with the entire experimental protocol by demonstrating the process of performing the tests as well as acquainting them with the various experimental procedures. During the second and third visits, they performed the experiments for the collection of data. Pre-exercise heart rate, blood pressure, VO_{2max}, flexibility and vertical jump test (VJT) were measured in the second visit while high intensity effort (HIE), agility and push up and hand grip strength were measured during the third visit. After arrival in the laboratory at 9 am, they took rest for half an hour to allow the cardiovascular and respiratory parameters to settle down. Then the pre-exercise heart rate was recorded from the carotid pulsation and blood pressure was measured by the sphygmomanometric auscultatory method. Body height and body mass were measured to an accuracy of ±0.50 cm and ±0.1 kg, respectively, by using a weight measuring instrument fitted with height measuring rod (Avery India Ltd., India) with the subject standing barefoot and wearing lowest amount of clothing. The body surface area (BSA) and body mass index (BMI) were calculated by using the following equations (13, 14).

$$BSA\ (m^2) = (\text{Body mass})^{0.425} \times (\text{Body height})^{0.725} \times 71.84$$

$$BMI\ (kg/m^2) = \text{Body Mass (kg)} / (\text{Body Height in meter})^2$$

Subjects were asked to avoid any energetic activity (e.g., participating in regular training, competition, etc.) on the days of evaluation and took light breakfast 2 to 3 hrs before the examination (15).

Direct estimation of VO_{2max}:

The direct estimation of VO_{2max} was completed according to the protocol of Roy and Bandyopadhyay (15). Subjects performed an incremental bicycle exercise on Muller's magnetic brake bicycle ergometer (Model of the Max-Plank Institute of Ergology, Germany). After a warm up exercise at 50W intensity for a duration of 5 min, the first incremental working intensity was set at 100W and thereafter the intensity was increased by 20W every 3 minutes until the subject stopped due to exhaustion. The criteria of exhaustion were set as:

i) a heart beat within 10 beats·min^{-1} of the age-predicted maximum heart rate

ii) a respiratory exchange ratio of more than 1.15

iii) levelling off, i.e., no further increase in oxygen uptake took place despite further increase in work intensity, or the increase in oxygen uptake was less than 100 ml.min^{-1}.

Douglas Bag (150 L) was used to collect the expired gas with the help of a low resistance Collin's Triple "J Type" valve. Volume of the expired gas was measured in a wet gasometer (Toshniwal, Germany, CAT. No. CG05.10). Scholander micro-gas analysis apparatus was used to analyze the gas samples. VO_{2max} values were corrected to standard temperature pressure dry (STPD).

Measurement of flexibility by modified sit and reach test:

Flexibility was measured by modified sit and reach test method (15, 16). Subject sat on the floor in barefoot with legs stretched out straight ahead. The soles of the feet were placed parallel against a wooden box called "sit and reach box". Both knees were fixed and pressed flat to the floor. The subject assumed a sitting position with the head, back, and hips against the wall (90" angle at the hip joint) and the feet against the sit and reach box. A sliding measurement scale or yardstick with a range of 0 to 90 cm was placed on the box. The subject was asked to place hand over hand and reach out level with the measurement scale. The initial reach was measured by keeping the head and back of the subject in contact with the wall; only scapular abduction was allowed. The sliding measurement scale was then slid along the top of the box until the zero point of the scale was even with the tip of the fingers. The subject was asked to reach forward along the measuring line as highest as possible. It was ensured that the hands stayed at the same level, not one reaching further forward than the other. The subject reached out and held that position for one or two seconds while the distance was recorded. No jerky movement was allowed (16). After three practice reaches, the subject reached out and held that position for one or two seconds while the distance was recorded. Each participant repeated the test for three times with a gap of at least 5 min between the consecutive trials. The best of these three trials was recorded.

Determination of VJT Score:

Vertical jump test (VJT) was measured by following the vertical jump test method (17). The subject chalked the end of his finger tips and stood beside a wall and reached up with the hand closest to the wall, keeping the feet flat on the ground. The point of the fingertips was marked as standing reach height (M1). Then the athlete jumped vertically as high as possible with the attempt to mark on the wall at the highest reachable point of the jump (M2). The distance between M1 and M2 was recorded as the VJT score. The test was performed thrice with a gap of at least 10 minutes between the consecutive trials and the best of these three efforts was recorded (17).

Determination of HIE:

High intensity effort (HIE) was determined by 60-yard shuttle run test which comprised shuttles of progressing distances with subject's maximum effort (high speed and acceleration) (15). Three indicator cones were placed at the yard lines 5 yards apart. The subject started from one end, ran 5 yards and came back to the start point, then ran another 10 yards and back followed by another 15 yards and finally came back to finish the test at the start line. Thus a total of 60 yards' distance was completed in a shuttle manner. The subject was required to touch the line with their hand at each turn, for a total of five touches. The time taken to complete the entire run was recorded by a stop watch.

Measurement of agility:

Agility was measured by the shuttle run test (15). The subject was asked to run back and forth between two parallel lines as soon as possible. Two lines were set up 30 feet away from each other. Two wooden blocks were put behind one of the lines. The subject started running from the line reverse to the blocks. The participant ran to the other line and picked up one block and returned it to put behind the starting line, then returned another time to pick up the second block, then ran back with the block to place it back across the starting line. The time taken for the entire running period was marked out with the help of a stop watch.

Determination of upper body strength:

Upper body strength was determined from the push up test (18). The front leaning position was assumed by keeping the hands approximately shoulder width apart and feet together without shoes. The arms, back, buttocks and legs were kept straight from head to heels throughout the test. The test started with bending the elbow and lowering the entire body until the top of the upper arms were parallel to the floor and the elbows were bent at an angle of 90°. Then the subject return to the starting position by extending the elbows until the arms were almost straight. Subject was asked to perform this test in as many number as possible in one minute and the total number of times performed by the subject in one minute was counted and recorded. The test was performed three times with a gap of at least 10 minutes and the best score was recorded.

Determination of hand grip strength:

Hand-grip dynamometer was used to measure the hand grip strength of each hand (15). Subjects hold the dynamometer in the hand to be tested, with the arm at right angle to the body from the shoulder keeping the elbow straight and erect towards the front or dorsal side of the body. The base of the dynamometer rested on the first metacarpal (heel of palm), while the handle rested on the middle of four fingers. The subject squeezed the dynamometer with maximum isometric effort as fast as possible (within 1–2 sec) without making any movement of any other body part. In both the hands, the hand grip strength was measured in two postures, i.e., horizontal and vertical. Therefore, a total of four hand grip strength scores were obtained in each subject, i.e., left hand horizontal (LHH), right hand horizontal (RHH), left hand vertical (LHV), right hand vertical (RHV). Each subject performed the test for three times with a gap of at least 3 min between the consecutive tests. Best of the three trials was recorded.

Statistical analyses:

Data have been presented as Mean±SD. The normality of the distribution of data for each group was checked by Kolmogorov–Smirnov test. One–way analysis of variance (ANOVA) was carried out to detect the significance of difference and Post-hoc Tukey analysis was performed to detect inter group difference by using SPSS software Version 16.0. Significance was set at an alpha lev-el of 0.05.

Results

Values of age, body height, body weight, socio-economic status, duration of training, BMI, BSA, pre-exercise heart rate and blood pressure were presented in Table I. Age, socio-economic status and body height did not show any significant inter group difference but body weight, BMI, BSA and pre exercise heart rate were significantly ($p<0.05$) higher in the sedentary control group (Table I). Systolic and diastolic blood pressures were also significantly higher in sedentary control group than the Swimmer and Water Polo groups. However, the duration of training did not show any significant difference between the two experimental groups.

Aerobic capacity (VO_{2max}), flexibility, VJT, agility, push up and hand grip strength score were tabulated

TABLE I: Physical and physiological parameters of the subjects.

		Socio-economic status (Kuppuswami score)	Age (yrs)	Training duration (Years)	Body height (cm)	Body weight (kg)	BMI (kg/m^2)	BSA (m^2)	Blood Pressure (mm of Hg)		Pre-exercise Heart Rate (beats.min^{-1})
									Systolic	Diastolic	
Sedentary (n=30)		16.13 ±2.47	22.79 ±1.32	--------	167.79 ±5.33	69.00 ±4.66	24.52 ±1.71	1.78 ±0.08	123.71 ±4.58	82.07 ±4.52	81.43 ±4.48
Swimmer (n=30)		16.03 ±2.93	22.71 ±1.23	6.13 ±1.09	167.68 ±5.46	62.57 ±4.85#	22.26 ±1.37#	1.71 ±0.09#	115.07 ±4.55 #	76.86 ±4.36#	72.79 ±3.27 #
Water Polo (n=30)		15.63 ±2.24	22.36 ±1.22	6.21 ±1.01	169.42 ±5.92	62.36 ±5.33@	21.76 ±1.95@	1.72 ±0.09@	115.78 ±4.58@	76.14 ±4.03@	72.86 ±3.51@
F		1.22	0.556	--------	2.065	16.559	25.632	6.024	0.221	0.71	36.020
Sig.		0.294	0.576	0.76	0.133	0.000	0.000	0.004	0.802	0.931	0.000
CI	S-SW	0.923 to 1.099	-0.67 to 0.87	------	-4.31 to 2.36	3.75 to 11.15	1.68x10^{-11} to 4.26x10^{-11}	0.02 to 0.13	-3.66 to -2.79	-1.96 to 2.50	5.57 to 10.76
	S-WP	0.956 to 1.114	-0.44 to 1.11	-------	-6.14 to 0.54	4.28 to 11.68	2.33x10^{-11} to 4.91x10^{-11}	0.01 to 0.13	2.76 to 3.69	-2.30 to 2.16	5.21 to 10.39
η^2		0.007	0.01	-------	0.05	0.28	0.37	0.12	0.005	0.001	0.452

Values are Mean±SD, Significance was set at an alpha lev-el of 0.05
df of between groups is 2, within group is 87 and total is 89
#$p<0.05$ (When compared between Sedentary and Swimmer groups)
@ $p<0.05$ (When compared between Sedentary and Water Polo groups)
η^2 = effect size, CI = Confidence interval (Multiple Comparisons)
S = sedentary group, SW = Swimmer Group, WP = Water Polo group.

TABLE II : Values of VO_{2max}, Flexibility, VJT, HIE, Agility, Push up and Hand grip strength.

		VO_{2max} ($ml.kg^{-1}.min^{-1}$)	Flexibility (cm)	VJT (cm)	HIE (sec)	Agility (sec)	Push Up (times/min)	Hand grip strength (kg)			
								LHH	RHH	LHV	RHV
Sedentary (n=30)		35.97 ±7.45	19.5 ±5.28	31.51 ±5.24	8.63 ±0.89	11.89 ±0.49	15.07 ±3.63	29.57 ±3.81	29.0 ±4.29	29.21 ±4.12	29.29 ±4.05
Swimmer (n=30)		48.45 ±6.61#$	26.39 ±5.67#	42.28 ±5.59#	7.12 ±0.61#	10.60 ±0.83#	28.07 ±4.72 #	30.57 ±4.45	30.93 ±4.38	30.43 ±4.75	30.86 ±4.51
Water Polo (n=30)		54.33 ±6.59@	23.84 ±5.24@$	38.74 ±5.51@	7.87 ±0.67#$	10.03 ±0.48#$	20.29 ±3.14 #$	29.43 ±4.83	30.43 ±3.89	30.21 ±4.03	31.29 ±3.52
F		60.744	14.242	21.828	25.490	80.44	108.786	1.417	0.327	1.330	2.269
Sig.		0.000	0.000	0.000	0.000	0.000	0.000	0.248	0.722	0.270	0.109
CI	S-SW	-14.82 to -7.02	-11.16 to -4.25	-13.15 to -6.11	0.99 to 1.99	0.91 to 1.63	-16.37 to -11.77	-4.04 to 1.24	-2.99 to 2.52	-4.72 to 0.92	-3.63 to 1.16
	S-WP	-21.76 to -13 .96	-6.75 to 0.15	-9.70 to -2.66	0.21 to 1.21	1.51 to 2.23	-7.47 to -2.87	-2.27 to 3.01	-3.65 to 1.85	-4.05 to 1.58	-4.53 to 0.26
(η^2)		0.583	0.247	0.334	0.369	0.648	0.714	0.032	0.007	0.28	0.049

Values are Mean±SD, Significance was set at an alpha lev-el of 0.05.
#p<0.05 (When compared between Sedentary and Swimmer group)
df of between groups is 2, within group is 87 and total is 89
@ p<0.05 (When compared between Sedentary and Water Polo groups)
$p<0.05 (When compared between Swimmer and Water Polo groups).
LHH=left hand horizontal, RHH=right hand horizontal, LHV= left hand vertical, RHV= right hand vertical.
η^2 = effect size, CI = Confidence interval (Multiple Comparisons)
S = sedentary group, SW = Swimmer Group, WP = Water Polo group.

in Table II. HIE and agility depicted significantly (p<0.05) lower values in swimmer group than the control and Water Polo groups while flexibility, VO_{2max}, VJT and push up exhibited significantly (p<0.05) higher values in swimmers than the control and Water Polo groups. Hand grip strength did not show any significant inter-group difference.

Discussion

Agility, force, speed and strength are the major components of motor fitness that is a main determinant of sports performance (25). The pragmatic objective of the current study was to evaluate the important fitness profile parameters in young male Indian Water Polo players and Swimmers of Kolkata, India and to compare the data with their sedentary control group and overseas counterparts. However, it is a limitation of the present study that role variation in Water Polo players or event specific selection of swimmers could not be undertaken in the study due to lack of availability of subjects.

The physical parameters did not show any significant difference between the Swimmer and Water Polo group. However, the body weight was significantly (p<0.05) lower in the experimental groups when compared with the control sedentary group. Due to such significant difference in body weight parameter, significantly (p<0.05) lower BMI and BSA scores among Water Polo and Swimmer groups were also depicted when compared with the sedentary control group.

VO_{2max}:

Water Polo players showed significantly (p<0.05) higher values of VO_{2max} than the swimmers and sedentary subjects (table 2). This finding corroborated with the earlier observation that elite male Tunisian Water Polo players had approximately 6-20% greater oxygen consumption than the competitive Swimmers (8). Water Polo is very intermitting with intense bursts of activity occurring and movement varies according to the players' positions in the pool (8). The better VO_{2max} data of this study could be related to the involved muscle mass during the exercises, as the players are accustomed to training with regard to the eggbeater kick in all sessions (19). These task strategies might be the main factor of active muscle mass that gives better aerobic capacity to the Water Polo group in comparison to both the Swimmer group and sedentary control group (19). Existence of such significantly higher VO_{2max} value among Water Polo players might be attributed to their involvement in a high-volume and intensity level of training (8). Georges and Richard (20) reported contradictory finding with higher VO_{2max} in international American Swimmers than the Water Polo players. Similar contradictory finding was also reported with better aerobic capacity in Israeli Swimmers than the Israeli Water Polo players (7). VO_{2max} of the presently studied Water Polo players (52.89±8.42 ml.kg^{-1}.min^{-1}) was lower than their Canadian and French (53.3 ml.kg^{-}1.min^{-1}, 57.4±5.6 ml.kg^{-}1.min^{-1}) counterparts (2, 21). VO_{2max} of the presently studied Swimmer players (48.45±6.61 ml.kg^{-1}.min^{-1}) was lower than European, Spanish and Scottish Swimmers (59.98±5.68 ml.kg^{-1}.min^{-1}, 59.93±6.16 ml.kg^{-1}.min^{-1} and 58.98±5.36 ml.kg^{-1}.min^{-1}) (22-24).

Agility:

In sports, an athlete's speed and agility are the most important motor capacities (25). Present study depicted significantly ($p<0.05$) higher agility score in Water Polo players than the Swimmers and sedentary control group (Table II). Similar observation was reported in Brazilian young (16.3±1.18 yrs) Water Polo players who completed the agility test quicker than their Swimmer counterparts (26). Existence of higher agility score in Water Polo players might be attributed to their body movements from a horizontal to a vertical position in various directions during the actions of preparing the move, attack and defence (26). Better agility score of Water Polo athletes might be attributed to their prompt horizontal displacements and rapid rotational movements during the game (26). These techniques are more frequently used in their counter attack activities practiced during their regular training as well as during the competitive matches when two equally trained teams take on each other (26). Better agility of Water Polo athletes might further be attributed to their short bursts of rotational movements that involve both the hands to remove the ball floating in an arch (27, 28). From this discussion it may be hypothesised that Water Polo players possess better agility score than their Swimmer counterparts as also suggested in earlier investigations (29, 30).

HIE:

Swimmers of the present study had significantly ($p<0.05$) higher HIE score than the Water Polo and Sedentary control group (Table II). Similar finding was reported in Israeli Swimmers and Water Polo players, indicating the tendency of having higher anaerobic capabilities in Swimmers in comparison to their Water Polo counterparts (7). This important contribution of anaerobic metabolism depends on the type of exercise such as length and number of intervals, rest time and mode of exercise in swimmers (7). This may be partly dependent on the glycolytic energy system but mostly depend on the ATP-CP phosphagen system for energy supply (7). In competitive swimming, the required energy is supplied by some combination of phosphate energy, anaerobic glycolysis, and aerobic combustion of carbohydrate, fat, and protein (31). The specific assistances of these systems depend on both the length of the race and the intensity of the pace used (32). It is a limitation of the present study that both the short and middle distance swimmers have been recruited in the study as the availability of event specific swimmers would have been inadequate to conduct the study.

It is well established that diet and training enhance the athlete's ability to both produce and tolerate lactic acid (33-35). Moreover, commonly practiced continuous training and interval training by the swimmers might have helped them to achieve significantly higher HIE score.

HIE value (7.12±0.63sec) of Indian male Swimmers was higher than their Spanish counterparts (9.83±1.36 sec) (36).

Flexibility:

All sports involve considerable training time in activities to develop neuromuscular skill, resistance training for muscular strength and stability, and cross-training for flexibility and weight management

(33). The flexibility score of Swimmers of the present study was significantly ($p<0.05$) higher than the Water Polo players and sedentary control subjects. American Swimmers had better strength, flexibility, and high levels of kinaesthetic awareness (37). Flexibility of Indian male Swimmers (25.04±9.23 cm) was higher than their Spanish counterparts (9.48±6.71 cm) (36). Swimmers are generally flexible because of their dynamic warm-up tends to include some form of dynamic stretching and plyometric activities and specific motor pattern movements as well as breaststroke swimming (38, 39). A dynamic warm-up has been found in Swimmer that enhanced flexibility scores (38). This may be the reason that gives the better flexibility score of Swimmers.

Push up:

Push-ups are a measure of upper body strength (40). Muscles involved to perform the push up test are pectoral muscles, triceps, anterior deltoids, serratus anterior, coracobrachialis and the midsection are mainly involving in push-ups exercise (41, 42). Swimmers had significantly ($p<0.05$) higher value of Push Ups compared to the Water Polo and sedentary control group in the present study. It might be speculated that swimmers exert more forceful hand strokes that enabled them to gain more strength in the arm musculature. Three best swimming strokes improved upper body strength: especially, butterfly, front crawl and breaststroke (43). These trainings give better upper body strength of Swimmers (43). These may be the facts of having better push up score of Swimmers than the Water Polo Players.

However, further precise explanation regarding the exact physiological mechanism behind such finding is beyond the scope of the present study. The data of push up score of swimmers and Water Polo players could not be compared due to unavailability of data in other population.

VJT:

Vertical jump test (VJT) is used to assess the leg strength or leg power which is a vital factor of fitness testing in athletes as well as in sedentary population (44, 45). Swimmers achieved significantly higher value of VJT score than the Water Polo and sedentary group. This finding corroborated with the previous research that also revealed significantly higher value of VJT score in swimmers in comparison to the sedentary control group and boxers (45). Existence of higher value of VJT score in Swimmers in comparison to other athletic group and sedentary control group might be attributed to their participation in dry land training that includes several jumps which makes their leg muscles stronger to achieve more height while jumping (46). This in turn helps them to especially improve their jumping ability (46). The value of VJT (33.22±7.95 cm) of Indian male Water Polo players was lower than the Croatian Water Polo players (145.24± 6.71 cm) (47).

Hand grip strength:

Hand grip strength did not show any inter group significant difference. But swimmer athletes exhibited greater value of hand grip strength of both hand (vertical and horizontal) probably due to the fact that they exert frequent and forceful hand strokes during their event and that enabled them to develop better grip strength (42).

Water Polo players were superior in cardiorespiratory fitness (VO_{2max}), anaerobic capacity (HIE) and agility score than the Swimmers since Water Polo involves very intermitting and intense bursts of activity occurring throughout the event and the movement varies according to the players' positions in the pool. It may be hypothesised that higher agility score in Water Polo players might be attributed to their body movements from a horizontal to a vertical position in various directions during the actions of preparing the move, attack and defence. While higher values of VJT and push up in swimmers might be attributed to their participation in dry land training that includes several jumps which in turn help them to especially improve their jumping ability as well as partly dependent on the glycolytic energy system. This is indicating the tendency of having higher anaerobic capabilities in Swimmers in comparison to their Water Polo counterparts.

Practical application of the study:

This is the first study that reported the data of fitness profile parameters in Swimmers and Water Polo players from the eastern part of India and the data would serve as the National standard of data of fitness profile parameters in eastern Indian Swimmers and Water Polo players.

Limitations of the study:

The dietary patterns and fluid intake patterns influence the fitness profile parameters of the Swimmers and Water Polo players. But, it is a shortcoming of the study that these parameters were not evaluated in this present study.

There are different events (short distance, middle distance, long distance, etc) depending on the type of the strokes applied by the swimmers. Water Polo players also have positional role variation in the team. However, in the present study the event or role specific evaluation of these players could not be undertaken due to lack of availability of subjects.

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