International Journal of Life science & Pharma Research

SIMILARITIES AND DISTINCTION PATTERN RECOGNITION OF PHYSICAL FITNESS RELATED PERFORMANCE BETWEEN AMATEUR SOCCER AND FIELD HOCKEY PLAYERS

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ABSTRACT

This study aims to identify the components of physical fitness related performance pattern of similarities and variation among soccer and hockey amateur players**.** Amateur soccer (N=31) and hockey players (N=31) were recruited from Johor sports school, Malaysia. Standard battery fitness tests were conducted, and principle component analysis (PCA) was employed to identify the most significant physical related performance components and to determine the similarities and variations of the components between the two sports. The PCA after varimax rotation revealed two varifactors (VF) for both soccer and hockey (eigenvalues>1). The VF with higher positive factor loadings contains four main components which include vertical jump, standing broad jump, sit and reach and velocity of agility while the other VF indicated three components containing maximum pushups, sit–ups and V_{O2max} suggesting the need for lower body strength and endurance for soccer players. Similarly, for hockey, the first VF included speed, vertical jump, standing broad jump and agility. The second VF contained maximum pushups, maximum sit-ups, and V_{O2max} recognizing the requirement of lower limb power and core body strength. Identifying physical fitness patterns for amateur soccer and hockey players might help the coaches to structure training programs to suit the need for each sport.

Key words: Pattern recognition, Amateur soccer players, Amateur field hockey players, Principle component analysis, Physical fitness performance related components.

INTRODUCTION

Played on a relatively measured pitch with the same number of players and for an equivalent length of time, physiologically field hockey is closely matched from various perspectives to soccer. While intermittent in nature, players must perform continuously for 90 minutes with just one 10-15-minute interval. This places a high demand on the aerobic system, and good aerobic endurance is required to support repetitive bouts of high-intensity exercise [1]. Similarly, other studies reported that anaerobic power and anaerobic endurance are higher in amateur soccer and field hockey players [2-4]. Involvement in the game across different levels requires, among others the ability for the players to respond to the physical demands of the game. Furthermore, there are many important physiological characteristics as well as fitness attributes required for improved performance in both sports. Although each of these sports has its distinctive skills, tactics, and movement patterns, they may all have similar physiological demands such as high aerobic power, high agility and increased anaerobic capacity [5]. These physiological capacities allow the team-sport player to repeat sprints often with quite short recovery periods over a prolonged duration. This type of activity is usually referred to as Prolonged High-Intensity Intermittent Exercise [6-8].The development of certain physical fitness components such as motor skills, speed, body flexibility, stamina, core body strength, upper body strength, explosive power, agility, and leg power are possible outcomes of effective performance in the sport of soccer and field hockey [9-11]. Also, it was reported that the natural tempo of soccer and field hockey is fast and involves interval aerobic and anaerobic activities [12]. As a result of this, therefore, all the major muscle groups are activated during the games. In another development, previous researcher inferred that aerobic exercises stimulate both the respiratory frequency and the heartbeat [13]. By so doing, calorie disbursement escalates and as a result of this, body size declines and the health of both the breathing and cardiac systems develop. However, these related physical fitness parameters serve as the vital prerequisite for efficient delivery of performance through the improvement of body resistance and consequently tailored to the adaptation of the playing techniques involve in the two sports [14]. Nevertheless, it was described that soccer and field hockey sports required cardiovascular endurance and agility to meet up with the nature of the game since the two games involved sudden stops and repeated runs [15]. Therefore, cardiovascular endurance provides substantial benefits to the players to perform at their peak. Similarly, soccer and field hockey games need upper, lower as well as core muscle strength which activates the main muscle groups, particularly leg (hamstring, quadriceps, calf and hip muscles), arm (triceps, forearm) and shoulder (deltoid). The ability of these muscle groups to respond to the demand placed upon them in the course of the game helps the players to perform efficiently [16]. In the same direction, other researchers revealed that body flexibility is essential in the successful performance of the two sports because it intensifies muscle mass and strengthens fibrous tissue and, by doing so, reduces injury risk [17]. All these donate to developing a healthier, stronger and more injury-resisting body. Likewise, it was stated that speed, power, flexibility and fast-reacting capabilities assist the players of both games to alter direction fast through position during the game [18]. All of these physical fitness related components are vital to the performance of the games; the more the players possess the components, the better their performance delivery in the games [1- 2]. Soccer and field hockey are team sports that involve a total body workout that comprises of both aerobic and anaerobic components. These two sports are complex in nature, such that their successful performance depends on many factors. Although the greater part of the game is spent in low-level activity such as walking and light jogging, repeated back-to-back sprints, render speed and cardiovascular endurance an important characteristic in players. For this reason, both soccer and field hockey training program must meet the demands of a very physically challenging, multi-sprint sport. However, individual variation may exist based on the related fitness requirement for two sports. Understanding the specific fitness requirement of the sports will enable the designation of the training program that can suit the need of each sport for a better performance execution. This study aims to identify the components of physical fitness related performance pattern of similarities and variation among soccer and field hockey amateur players.

MATERIALS AND METHODS

Participants

A total number of 62 players participated in this study. The players were amateur soccer players (31 players; 14.55 ± 0.51) and field hockey players (31 players; 15.84 ± 1.00) drawn from Johor sports school, Malaysia. The sports school serves as the center for training and generating players that will consequently be promoted to state and national players' level respectively.

Ethical consideration

The coaches and the managers of the academies were informed about the purpose of the research. Writing approval was obtained, and all the players signed consent forms.

Players Fitness Examination

Core muscle strength

The test was executed according to the recommended method for physical fitness tests [19]. Participants lay on their back with their knees at 90° around right edges while both feet were situated level on the floor. They put their hands against their chest where they should stay throughout the test. In the test process, a supporter held the participants' feet put on the ground. Participants sat up until they touched their knees to both elbows; then, they came back to the floor. The movement was frequented as many times as possible. The aide totaled and recorded the quantity of right finished push-ups. The test was measured just once attributable to the impact of exhaustion.

Upper Muscle strength

The participants assumed a prone position on the floor with the hands directly underneath the shoulders, legs extended and together, and toes tucked under so they are in contact with the floor, (push up position). The participants then push with the arms until they are fully extended and then lower their body until their chest down towards the floor. At this point, the line from the head to the toes should be straight. All of these movements were executed only by the arms and shoulders. The score was determined by the number of push-ups while maintaining correct form. The test was also administered ones to avoid fatigue.

Endurance capacity test

The multistage 20-m shuttle run test was implemented to acquire the participant's maximal oxygen uptake [20]. Every athlete kept running for whatever length of time he/she could afford until could no more keep pace with the velocity of the tape. Test results for every participant were expressed as an anticipated VO_{2max} accomplished by checking the last level and ended shuttle number at the time when the participant voluntarily resigned from the test. In spite of the fact that motivation and drills of the participants might influence their scores, it is still a legitimate test in assessing maximum oxygen uptake and can be performed in a considerably large number of participants minimizing expenses and time. The predicted VO_{2max} was determined using the

FORMULA

(ml/min /kg) = *Multi-Stage Shuttle Run 20m (MSR20m) level 1 distance (meters)* × 0.0084 + 36.4 as suggested by previous researchers [21].

Speed velocity test

Linear sprint speed was evaluated over 30 m. Infrared speed trap (Brower Timing system) were positioned at the starting line (0 m) and ending (20 m) at a height of around 0.5 m off the ground [22]. Participants started the test from a standing start at a distance of 0.3 m from the initial timing gate before starting the test taking after a countdown from the lead researcher. The participants were told to keep running at maximal velocity throughout the full length of time of the sprint test. To avoid a reduction in sprint speed on approach to the 20 m gate, an associate of the researchers was placed 2 m outside the final timing gate and provided verbal reinforcement throughout each effort. The subjects were told to keep up the maximal pace until passing the marker on which the mentor stood. Participants performed two reiterations with the best (fastest) times utilized for statistical analysis. At least 4 min of restoration were given between repetitions.

Leg explosive power

A Vertec testing gadget (M-F Athletic Co., Cranston, Rhode Island) was utilized to decide vertical jump height (cm), which is a legitimate and solid measure of lower body power [23]. To surface this test, a prepared tester attuned the height of the color-coded plastic vanes such that it paralleled to the athlete's standing reach height. The vane stack was then raised a standardized distance (corresponding to the participants' anticipated jump) so the participant would not jump higher or lower than the arrangement of the vanes. Utilizing a countermovement, the participant flexed the ankles, knees, and hips and swung the arms in an upward movement, tapping the highest conceivable vein with the fingers of the dominant hand. Every participant performed three jumps with 40-60 seconds rest between every jump. The better of two trials was recorded and utilized for statistical analysis.

Body Flexibility

The flexibility of the lower back and hamstrings were determined by the sit and reach test [24]. The participants performed two trials, and the best one was recorded for further analysis.

Agility Test

Agility was determined by the 't-test agility test. The protocol was conducted as previously described by other researcher [25]. Pointers are set up 10-5-5 meters from a line marked on the ground forming a 'T'. The participants run from the 10 m marker near the line (run in distance to form up speed) and via the 5 m markers, turns on the line and runs back over the 5 m markers. The time is documented using infrared speed trap (Brower Timing system), from when the participants first run through the 5 m back to 10 m marker and stopped when they return through these markers. Each participant performed two maximal attempts, and the fastest time was recorded for further analysis. The participants were encouraged not to overstep the line by too much as this will increase their time.

Statistical Analysis

Data and pre-data Treatment

A total of 496 matrices sets of the data point (8 variables × 62 datasets) were computed in this analysis. The total of missing data in the matrices was very small (~3 %) compared to the overall data recorded. The normalcy of the data set was checked, and the outliers from the data were removed. However, in order to facilitate the data analysis, the nearest neighbor method was applied using XLSTAT 2014 add-in software [26-28]. This method examines the distance between each point and the closest point to it. The nearest neighbor method is the simplest methods, where the end points of the gaps are used as estimates of all missing values [26, 27]. The equation applied in this method is shown in Equation (Eq) 1: All the data analysis was conducted using XLSTAT version 2014 add-in software.

Equation 1

$$y = y_1 \text{ if } x \le x_1 + \frac{x_2 - x_1}{2}$$

or

$$y = y_2 \text{ if } x \le x_1 + \frac{x_2 - x_1}{2}$$

Which y is the interpolant, x is the interpolant of the time point. Meanwhile, y_1 and x_1 are the range of coordinates for starting point of the gap, and the opposite for ending points of the gap is y_2 and x_2.

Application of PCA to the Study

Principal component analysis (PCA) is a robust statistical technique that involves the recognition of a pattern from an observed group or any given parameters. It offers insights into essential components for considering the spatial and temporal variability that explains an entire data set and consequently excluding the less essential components without loss of the original information from the data [29]. PCA is extremely important in extracting the most needed information from a large volume of the data set. This can assist in saving time, cost and energy since the original information is often retained. Moreover, the dimension of a huge data set can be trimmed down by using PCA, which is considered as one of the most prevalent and useful statistical methods for uncovering the potential structure of a set of variables. This method is used for explaining the variance of a large set of interrelated variables by transforming them into a new, smaller set of uncorrelated (independent) variables, namely principal components (PCs) [30,31]. PCs are orthogonal and unrelated to each other and have linear combinations of the original variables [32]. PCA can recognize the most significant variable pattern which can indicate the key source of relative performance indicators. Nonetheless, the use of PCA is extremely important in the area of sports and exercise science [33,34].Moreover, because of the ability of PCA to recognize the most significant variable pattern which can indicate the key source of relative performance indicators. Therefore, we applied PCA to this study through the elimination of the variables that have less factor loading based on distinct eigenvalue from the set of data [35,36]. The physical fitness related performance parameters were standardized through a Z-scale transformation to a mean of 0.0 and variance of 1.0 by applying Eq. (2)

Equation 2: $Z_{ij} = (X_{ij} - \mu) / \sigma.$

Z_{ij} is the j_{th} value of the standardize score of the measured variable i. Meanwhile, X_{ij} is the observation of j_{th} on i variable; μ is the mean value of the variable's, and σ is the standard deviation.The Z-scale modification technique was utilized to guarantee that the distinctive relative performance parameters had similar weights in the statistical analysis procedure. Furthermore, these changes were applied in the study to homogenize the fluctuation of the distribution and avert any classification errors that may occur from groups defined by variables of completely different sizes [37]. At that point, the data matrix was decomposed into scores or components and loadings (relationships between the original variables and the new PCs that were extracted from the analysis) for the variables. Bartlett's test of sphericity was performed at the start of the PCA to inspect the relationship between the variables utilized as a part of the PCA [38]. This test was able to estimate the probability that there were correlations in a matrix. The null hypothesis (H_o) in this test states that there is no correlation significantly different from 0 between the variables. While the alternative hypothesis (H_a), states that at least one of the correlations between the variables is significantly different from 0. As the computed *p*-value is lower than the significant level of alpha = 0.05, one should discard the null hypothesis (H_o), and receive the alternative hypothesis (H_a). The risk to reject the null hypothesis (H_o), while it is true is lower than 0.01%. When the null hypothesis (H_o) is rejected, then it is confirmed that the variables used in the PCA are correlated [39]. Nevertheless, the Kaiser-Meyer-Olkin (KMO) test was carried out to measure the sampling adequacy. These matrices measure the sampling adequacy for each variable along the diagonal and the negatives of the partial correlation/covariance on the off-diagonals. The diagonal elements should be higher than 0.5 at the barest minimum when the sample is sufficient for a given pair of variables [40]. If any pair of variables has a value which is less than 0.5, consider dropping one of them from the analysis. The PCs generated by PCA sometimes are not readily interpreted and should be rotated using any of a number of applicable methods such as varimax rotation. The goal of varimax rotation is to lessen the density of the constituents by rendering the higher loadings greater and the low loadings smaller within each component. The varimax rotation method was applied because this approach simplifies the factor structure and therefore, makes its interpretation easier and more reliable. In the varimax rotation method, only the PCs with eigenvalues greater than 1 (>1) are used and considered significan and to construct the new variables, known as varifactors (VFs) or factor loadings [41]. This approach is known as the Kaiser Criterion. The Kaiser Criterion is used to solve the problem of the number of components to be retained [42]. The numbers of VFs extracted by varimax rotations are equal to the number of variables in harmony with collective features and can include unobservable, hypothetical, and latent variables. The VFs are values that are used to measure the correlation between variables. VFs values which are greater than 0.75 (> 0.75) are considered "strong," the values ranging from 0.50 to 0.75 (0.50 ≥ factor loading ≥ 0.75) are considered "moderate," and the values ranging from 0.30 to 0.49 (0.30 ≥ factor loading ≥ 0.49) are considered "weak" factor loadings [43]. In this study, the VFs with absolute values greater than or equal to 0.60 were standardized as the selection threshold.

RESULTS

Table 1 shows the KMO measure of sampling adequacy. This test was implemented to determine the adequacy of the sampling to quantify as well as to make a reasonable interpretation based on the data gathered. Similarly, the test was conducted to ensure that the variables are not related to each other. From the table, the KMO value shows 0.65 and 0.69 which contributed 65% and 69% sampling adequacy for both the soccer and field hockey players respectively. Therefore, based on this results it is evident that there is no multicollinearity observed among the original variables and that enabled us to proceed further with the analysis having satisfied the measure of the sampling adequacy. Figure 1 outline the eigenvalue for the soccer and field hockey players. From the figure, it can be observed that two components were identified by the PCA for both soccer and field hockey as the most essential due to their higher eigenvalues greater than 1 (>1). These components were retained and utilized as an input variable for further analysis. Table 2 reveals the PCA after varimax rotation carried out for both the soccer and field hockey players. It can be seen from the table that from VF1, four components out of the eight performance indicators satisfied the 0.60 factor loading threshold for soccer players, similarly, from VF2, of the same players, identified three components with a positive higher factor loading. Nevertheless, VF1 from the field hockey players identified four components with higher positive factor loading, while VF2 from the same group identified three components with a positive higher factor loading. These indicators are then classified as the essential components that are mainly required for the performance in soccer and field hockey games across the amateur levels of expertise. Figure 2 projects the most significant components for soccer and field hockey players after varimax rotation. Additionally, the contribution of each varifactor within the components as well their variability is shown. It can be observed from the figure that VF1 and VF 2 contributed to about 54.06% of the total data set and the variability of 27.74% and 26.32 % for soccer players. However, the VF1 and VF2 for field hockey players contributed to about 58.66% of the whole data set with a variability of 37.12% and 21.53% respectively. Figure 3 shows the similarities and variances of the physical fitness related components between the soccer and field hockey players. From the table, it can be observed that the whisker plots (a) and (b) indicates the optimum needs of velocity speed and maximum pushups for both soccer and field hockey players. Whisker plot (c) reveals the need for a higher maximum sit-up (core body strength) for field hockey players compared to soccer players. In the same vein, whisker plot (d) reflects the requirement of slightly higher vertical jump (leg power) in field hockey players as opposed to soccer players. Moreover, whisker plot (e) reveals the needs for greater standing broad jump (explosive power) in soccer players as compared to field hockey players, while whisker plot (f) narrates the requirement of more sit and reach (flexibility) among field hockey players in comparison to soccer players. However, whisker plot (g) shows the needs for higher velocity of agility among field hockey players compared to soccer players. Also, whisker plot (h) indicates needs for more predicted VO_{2max} (Maximum oxygen consumption) among soccer players as opposed to field hockey players.

Table 1
Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy

Components	**Soccer**	**Field hockey**
20m V. (ms^{-1})	0.404	0.686
M. Push-ups (reps)	0.602	0.603
M. Sit-ups (reps)	0.688	0.550
V. Jump (cm)	0.618	0.858
S.B.J. (cm)	0.740	0.600
S. A. R. (cm)	0.678	0.584
V. Agility (ms^{-1})	0.629	0.791
VO_{2MAX} (ml/kg/min)	0.629	0.750
KMO	0.649	0.694

Note: V of 20m Speed= Velocity of 20m Speed, M. Push-Ups= Maximum Push-ups, M. Sit-Ups= Maximum Sit-Ups, V. Jump (Cm) = Vertical Jump, S.B.J. (Cm) = Standing Broad Jump, S.A.R. (Cm) = Sit and Reach (Cm), $V0_2max$= Maximum oxygen Consumption.

Table 2
Varifactors after varimax rotation and the possible source of the components in the study

Parameters	**Soccer**		**Field hockey**	
	VF1	**VF2**	**VF1**	**VF2**
20m V. (ms^{-1})	0.43	-0.33	0.79	0.30
M. Push-ups (reps)	0.23	0.75	-0.37	0.60
M. Sit-ups (reps)	0.14	0.83	0.10	0.84
V. Jump (cm)	0.77	0.01	0.80	0.05
S.B.J. (cm)	0.65	0.46	0.78	-0.18
S. A. R. (cm)	0.68	0.20	-0.39	-0.39
V. Agility (ms^{-1})	0.69	0.06	0.73	0.10
VO_{2MAX} (ml/kg/min)	-0.06	0.70	0.53	0.62
Eigenvalue	2.76	1.57	3.18	1.51
Variability (%)	27.74	26.32	37.12	21.53
Cumulative %	27.74	54.06	37.12	58.66

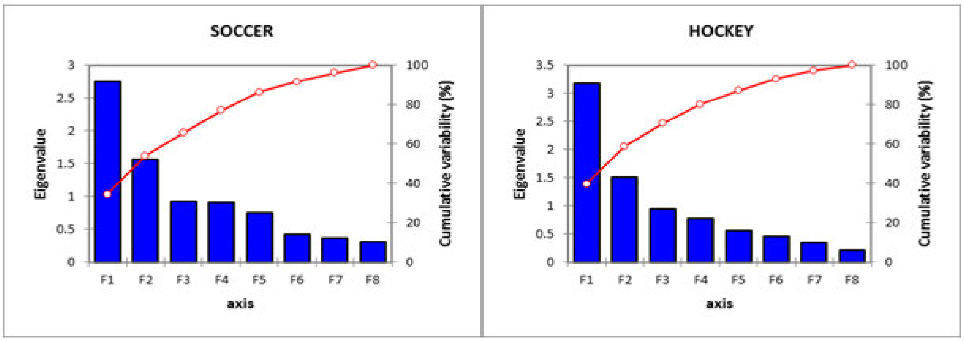
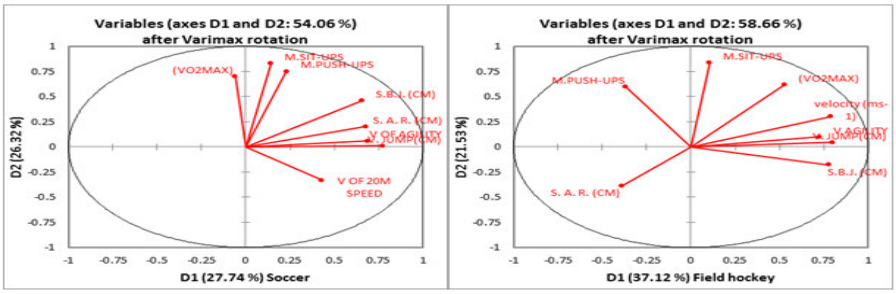


Figure 1
Scree plots for PCA.



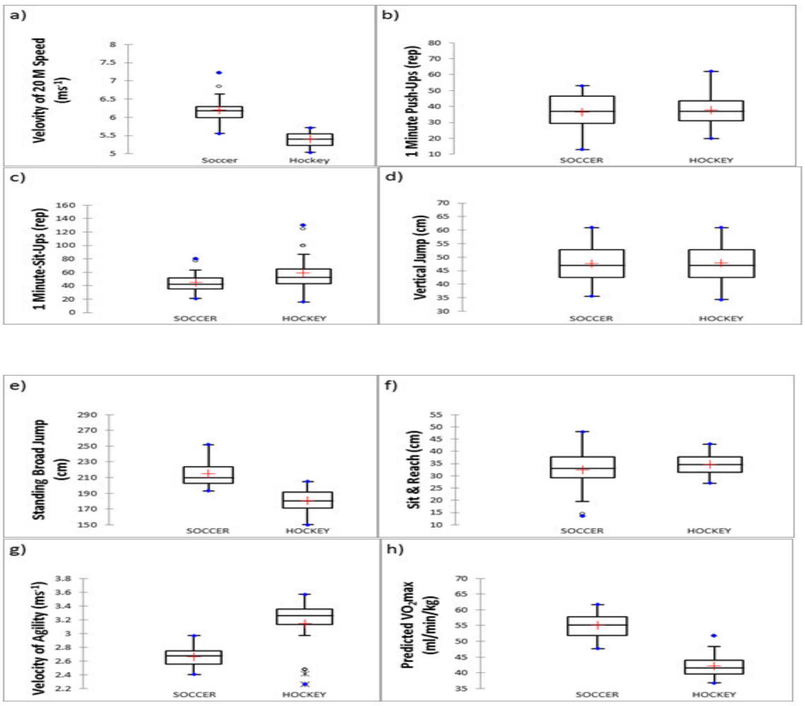


Figure 3
Box and whisker plot of the similarities and variability of the physical fitness related components among the two sports

DISCUSSION

Soccer and field hockey are team sports that involve a total body workout which comprises of both aerobic and anaerobic components. Despite, the possible similarities of these games certain physical components could differentiate the successful performance of the players in the game. The purpose of the current study is to identify the components of physical fitness related performance pattern similarities and variation among soccer and field hockey amateur players. To accomplish the aim of this study, standard battery fitness tests were conducted, and PCA was applied to identify the most significant physical related performance components and to determine the similarities as well as variation of the components between the two sports. In the current study, VFs with absolute values greater than 0.60 were standardized as the selection threshold due to the fact that these values are considerably solid and stable, which indicates moderate to strong loadings on the extracted factors. VF1 from soccer contributes to about 27.74% of the total variability of the data set. It projects a positive factor loading from the vertical jump (0.77), standing broad jump (0.65), sit and reach (0.68) and velocity of agility (0.69). These components can be interpreted as lower body strength. The game of soccer is predominantly played with lower body parts, particularly the legs. All the outfield players in the game are expected to play the ball with their legs occasionally using their torso to intercept the ball at the midair or make a pass. Lower body strength in soccer is essential for tackling, twisting, and turning and also serve as the main function of the players' explosive power [44]. However, previous researchers inferred that soccer is a complete body sport and, for this reason, players must function as a whole and to achieve this ultimate goal, a soccer player needs to have a strong lower body which is a starting point that provides a base for support [45]. Likewise, it was revealed that the lower body strength plays a significant role while running. It helps to support the body forward and sustain balance which consequently increases overall speed [46]. Neglecting lower body strength in a soccer game may inflict negative impacts on the entire players' development by diminishing their abilities to reach an optimum velocity and alter directions quickly [47]. This is true because forces from the ground go up from each leg via the core and across the body in each step an individual take. Moreover, the contemporary soccer competitions are increasingly transforming to higher aggression with players predominantly striving for the positional role against one another by tackling and running with their lower body. Lower body strength is a necessary component of a physical fitness related attributes a soccer player should possess in order to enhance his entire skill set. Moreover, other researchers explained that lower body strength assists soccer players in achieving greater speed [44-48]. For example, in the process of linear acceleration, the force requires to accomplish comes from the ground through the legs. Equally, in the deceleration process as well as changing directions, a player needs to have stronger legs to provide a base upon which to stop dribbling abruptly or alter the direction. Nevertheless, the strengths have to be balanced on both legs to achieve better performance in the game. The VF2 from soccer accounts for about 54% of the total variation in the data set. It has a higher positive factor loading from maximum push-ups (0.75), maximum sit-ups (0.83) and VO_{2max} (0.70). These components can be referred to as endurance. Cardio respiratory endurance is essential in the game of soccer since the players are required to last the full 90 minutes of the game. During the game, the players are expected to do a lot of work both on and off the ball. They will make repeated runs support attacks, get into space to receive the ball, make runs with the ball, and chase back to defend, etc [49,50]. The energy required to do this is supplied aerobically, which requires the heart, lungs and blood system to provide oxygen to the working muscles throughout the game. Therefore, endurance is a fundamental necessity in the game of soccer [51]. The VF1 from field hockey reflects a total of 37.12% of the variability in the data set. It presents a high positive factor loading from the velocity of speed (0.79), vertical jump (0.80), standing broad jump (0.65), and velocity of agility (0.73). These sets of components can be classified as lower limb power. Previous researchers reported that lower limb power is central to a field hockey training program [1]. They stressed that though field hockey players aren't required to hold off physical challenges (when linked to other multi-sprint sports), lower limb power is needed for acceleration, speed and quick changes in direction. However, some researchers inferred that lower limb power allows players to shoot more powerfully and pass over a greater range of distances [52]. The unique demands placed on the lower limb in the game of field hockey sport is just as crucial as endurance because it provides the ability for the players to execute efficient movement through explosive power. Similarly, since field hockey game is played on a synthetic surface, and such places diverse strains on the body compared to grass [53,54]. For this reason, field hockey players require greater lower limb power to move them and cope with the demands of twisting, sudden change of directions as well as speed for the game. Nevertheless, other researchers opined that the principle and specificity of field hockey training program should dictate and mirror the game as closely as possible as such include lower limb power training to assist the players to adapt to the strain enforced by the artificial turf of the current game pitch [55,56]. This can help to minimize greater injury risk inherent in playing on synthetic surfaces. Careful planning is required to ensure that lower limb power can be effectively developed by amateur field hockey players without leading to overtraining and fatigue because of its vital contribution to the successful performance of the game. Similarly, the VF2 from the field hockey explains about 58.66% of the total variation in the data set. It shows a positive, high factor loading from maximum pushups (0.60), maximum sit-ups (0.84) and VO_{2max} (0.62). The components from this varifactor can be leveled as core muscle strength due to the relatively higher factor loading accounted by maximum sit-ups among the components. The “core” denotes to the muscles that are included in gripping the torso in place; the abdominal, lower back, and hip muscles involved in arranging the spine and pelvis. Pelvic firmness is the ability of the trunk and pelvic muscles to keep the spine and pelvis in its ideal position during sporting activity. When these structures are held in an optimal arrangement, then the muscles and joints of the lower limbs are able to work effectively [57]. The muscles of the lumbo-pelvic hip complex perform a vital role in coordinating movement [58]. In a field hockey game, core strength not only can influence the player’s ability to move fast and alter direction quickly but is essential to the capability to win tackles and run with the stick effectively. Moreover, some researchers reported that core muscles are imperative for a field hockey player as they function as a medium of endurance, posture, strength, power, coordination, and decreasing the likelihood of injury [59, 60].

CONCLUSION

The current study has successfully identified the components of physical fitness related performance pattern similarities and variation among soccer and field hockey amateur players. Although most of the components of physical fitness discussed in this article could be required in both games, certain specific components appeared to be more appropriate for the successful performance of one game than the other. The finding of this study, however, can be useful for coaches and sports managers to determine and to recognize the physical fitness patterns, similarities and variations for both amateur soccer and field hockey players as this might help the coach and the trainers alike to structure training programs to suit the need of each game.

Future Directions

This study serves as the basis for making more robust scientific comparisons through the identification of essential fitness components in relatively more similar sports. Future work should be directed towards the recognition of skills variations and similarities patterns among the two games.

ACKNOWLEDGEMENTS

The researchers wish to acknowledge the Johor sports, school, Malaysia for their immense contribution to the accomplishment of this study.

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