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Associations of biomotor and physiological measures with anthropometric characteristics in field hockey players: a survey on pre-competitive period

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Authors' Contribution: A – research design/planning; B – data collection/entry; C – data analysis/statistics; D – data interpretation; E – manuscript preparation; F – literature analysis/search; G - fundraising.

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Abstract

Background and Study Aim. Field hockey is a dynamic sport that involves a combination of speed, agility, and endurance, with players having to satisfy particular physical and physiological demands in order to perform at their best. The primary goal of this study was to investigate the association between field hockey player's anthropometric characteristics and biomotor and physiological measures.

Material and methods. For the purpose of determining the biomotor measures, muscular strength (MS), speed, and change of direction (COD) were used. The VO2 max, anaerobic power (AP), muscular endurance (ME), and vital capacity (VC) were used to determine the physiological measures. In the game of field hockey, twenty forwards, sixteen half-backs and ten defenders fulfilled all the outcome measures. The intensity and directionality of the association between biomotor and physiological tests and anthropometrics characteristics were determined by using Pearson's product-moment correlation coefficients (r), and positional differences were tested using analysis of variance.

Results. Body mass significantly affected performance metrics. Body mass was moderately negatively correlated with speed ($p<0.05$) and COD ($p<0.05$). MS ($p<0.01$), VC ($p<0.01$), AP ($p<0.01$) and VO2 max ($p<0.05$) were positively linked with body mass. Performance was also affected by height. Height is inversely correlated with speed ($p<0.01$) and COD ($p<0.01$). MS ($p<0.01$) and AP ($p<0.05$) had a moderate positive correlation with height. Body mass index (BMI) had a moderate positive correlation with speed ($p<0.05$), VC ($p<0.01$), and VO2 max, ($p<0.05$) but not with MS, COD, and ME. MS had a moderate negative correlation with COD ($p<0.05$) and a positive correlation with ME ($p<0.05$). Speed had a significant very large positive correlation with COD ($p<0.05$, $r=.729$), ME had a positive correlation with VO2 max, ($p<0.05$) and VC had a positive correlation with AP ($p<0.05$). There were no significant position differences in all the selected measures.

Conclusions. The study concludes that body mass, height, and BMI greatly affect hockey players' strength, speed, and endurance. This study recommends that hockey coaches and trainers consider body mass, height, and BMI while training players. Performance may be increased by targeting anthropometric aspects, including strength, speed, and endurance.

Key words: Anthropometric characteristics, Field hockey, Muscular strength, Muscular endurance, $VO_{2\ max}$.

Анотація

Зв'язок біомоторних та фізіологічних показників з антропометричними характеристиками у хокеїстів на траві: дослідження в передзмагальний період

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Передумови та мета дослідження. Хокей на траві - це динамічний вид спорту, який передбачає поєднання швидкості, спритності та витривалості, коли гравці повинні задовольняти особливі фізичні та фізіологічні вимоги, щоб виступати якнайкраще. Основною метою цього дослідження було дослідити зв'язок між антропометричними характеристиками хокеїста на траві з біомоторними та фізіологічними показниками.

Матеріал і методи. Для визначення біомоторних показників використовувалися м'язова сила (МС), швидкість та зміна напрямку (COD). Для визначення фізіологічних показників використовувалися VO2 max, анаеробна потужність (AP), м'язова витривалість (ME) та життєва ємність легень (VC). У грі у хокей на траві двадцять нападників, шістнадцять півзахисників та десять захисників виконали всі підсумкові показники. Інтенсивність та спрямованість зв'язку між біомоторними та фізіологічними тестами та антропометричними характеристиками визначалися з використанням коефіцієнтів кореляції Пірсона (r), а позиційні відмінності перевірялися за допомогою дисперсійного аналізу.

Результати. Маса тіла значно вплинула показники продуктивності. Маса тіла помірно негативно корелювала зі швидкістю ($p < 0,05$) та COD ($p < 0,05$). МС ($p<0,01$), ЖЕЛ ($p<0,01$), AP ($p<0,01$) та $VO_{2\ max}$ ($p<0,05$) позитивно корелювали з масою тіла. На продуктивність також впливав зріст. Зріст зворотньо корелює зі швидкістю ($p < 0,01$) та COD ($p < 0,01$). MS ($p < 0,01$) та AP ($p < 0,05$) мали помірну позитивну кореляцію зі зростанням. Індекс маси тіла (ІМТ) мав помірну позитивну кореляцію зі швидкістю ($p < 0,05$), VC ($p < 0,01$) та $VO_{2\ max}$ ($p < 0,05$), але не з MS, COD та ME. MS мав помірну негативну кореляцію з COD ($p < 0,05$) та позитивну кореляцію з ME ($p < 0,05$). Швидкість мала значну дуже велику позитивну кореляцію з COD ($p<0,05$, $r=.729$), ME мала позитивну кореляцію з VO2 max, ($p<0,05$) і VC мала позитивну кореляцію з AP ($p<0,05$). Не було жодних істотних відмінностей у положенні у всіх вибраних вимірах.

Висновки. Дослідження робить висновок, що маса тіла, зріст та ІМТ сильно впливають на силу, швидкість та витривалість хокеїстів. Це дослідження рекомендує хокейним тренерам та інструкторам з хокею враховувати масу тіла, зріст і ІМТ під час тренування гравців. Продуктивність може бути підвищена шляхом орієнтації на антропометричні аспекти, включаючи силу, швидкість та витривалість.

Ключові слова: антропометричні характеристики, хокей на траві, м'язова сила, м'язова витривалість, $VO_{2\ max}$.

Introduction

Field hockey is a summer Olympics team sport that needs players to demonstrate excellent physical and physiological talents [1]decelerations and changes of direction to assess these important match qualities. This investigation assessed the test-retest reliability of a novel 6x40m repeated shuttle sprint test (20m + 20m with a 180turn because of its fast-paced and demanding nature. In place of the former format, which consisted of two halves that lasted for 35 minutes each [2], competitive hockey matches are now divided into four quarters that last for 15 minutes each [3,4]. The intensity and tempo of the game are both increased as a result of this modification [3], which also provides players with more frequent opportunities to take breaks and formulate strategies, eventually leading to a match experience that is more dynamic and engaging [5]. A strong aerobic capacity and the ability to undertake repeated bouts of high-intensity efforts while simultaneously performing complicated stick and ball control with accuracy are two of the main performance markers that are required for top-level competition [6]. In field hockey, for players to be able to excel in competitive matches, it is necessary for them to possess particular physical characteristics [7]. These factors include height [8], weight, and Body Mass Index (BMI) [9]. It is very important for hockey players to possess these characteristics, which include speed, agility, endurance, and strength, in order to achieve success in the sport [10]. Both height and weight can have an effect on an athlete's power and balance, and BMI can give insight into an athlete's body composition [11,12].

In sports, there exists a correlation between the training technique and anthropometric characteristics such as the height and weight of the body, as well as the BMI. This is due to the fact that these criteria have the potential to impact the technique and tactics of competition, in addition to an athlete's ability to specialize within a specific discipline [13]. When Reilly et al., (2000) conducted research, they concluded that anthropometric (body mass, height and BMI) and physiological factors can be useful in a comprehensive monitoring program for young athletes with potential [14].The study by Hyka et al., (2017) investigates the relevance of the association between speed and body height, which has a negative correlation, and body fat percentage, which has a positive correlation. One of the studies by Castro-Piñero et al., (2010) has stated that a considerably higher level of performance was demonstrated by the group of individuals with normal weight compared to those who were overweight or obese [15]. It would appear that the weight of the body has a significant effect in the sprint performance of youngsters. According to X. Chen et al., (2020), the link between BMI and physical fitness index among college students were not linear. The physical fitness index performance of students who were underweight, overweight, or obese was significantly lower than that of students who were of normal weight [16].

Numerous studies have looked at the relationship between anthropometric traits and the physiological and biomotor traits of various populations [17–21]. As far as the authors are aware, there has been a limited amount of research conducted on the subject of the link between the biomotor and physiological features of field hockey players and their anthropometric characteristics [22]. Having a deeper grasp of these linkages is essential in order to determine the most critical performance goals that should be addressed during training for the players. The major objective of this research was to provide a description of the biomotor and physiological profiles of male hockey players, including their height, body mass, and BMI prior to the start of the respective competitive season. The second objective of the research was to find out the association between biomotor and physiological profiles of field hockey players. The third objective was to ascertain whether or not these measures differed among the three distinct playing positions that were put together (Defenders, midfielders, and forwards).

Methods

Subject

The research included 46 male hockey players, ages 19.4 ±1.82, who had competed at the intercollegiate level with at least six years of prior hockey experience, hailing from Kerala, India. The Institutional Ethical Committee of Pondicherry University, India, gave the study's ethical approval in accordance with the Helsinki Declaration. The participants were informed in writing and vocally about the goals and specifics of the current study before their consent was obtained to make sure they understood. Written consent was voluntarily given by each player to participate in the study.

Testing procedures

The data for the tests were gathered at two distinct times, not over the course of one week during the pre-competitive period. The outcome measures used in this analysis give considerable supporting data for the study's findings. To measure the anthropometric characteristics, body mass with a digital weighing machine (HD-93), participant's height was measured with a traditional stadiometer (MCP 2m/200CM Roll Ruler Wall Mounted Growth Stature Meter), and BMI with the formula of body mass (kg) /height (m^2) were measured. Metrics such as muscular strength (MS), speed, change of direction (COD), and muscular endurance (ME) are considered in biomotor measures. The physiological measures used in this investigation comprised anaerobic power (AP), VC, and $VO_{2\ max}$. Participants were requested to refrain from vigorous exercise 24 hours before testing, have a regular meal and avoid coffee three hours before testing. Individualized warm-ups are provided to each participant in order to familiarise them with the test and prevent injury. These warm-ups include both general and specific, as well as two or three free testing trials, with a two to three-minute break between each trial.

Bio motor measures: - In bio motor measures, MS was tested using a hand grip dynamometer (Smedley hand dynamometer), which is widely used to test the hand grip strength. The interclass correlation (ICC) for test-retest reliability was 0.98 (95% confidence), and the CI is 0.943–0.993. The speed was assessed using the widely used 50m dash test, which was measured with three timers, and a hand stopwatch (NIVIA JS 609 Digital Stop Watch, Freewill Sports Pvt. Ltd., India) was used to acquire measurements of the participants' speeds. ICC for test-retest reliability was 0.95 (95% confidence), and the CI is 0.861–0.984. The COD was assessed using the Illinois agility test, which is an approved test for measuring COD, and the best time from the three trials was used for the analysis. The COD was recorded using a handheld stopwatch (NIVIA JS 609 Digital Stop Watch, Freewill Sports Pvt. Ltd., India). ICC for test-retest reliability was 0.98 (95% confidence), and the CI is 0.943–0.994. The ME was examined using the sit-up test, which is a commonly used test to determine ME (trunk). The maximum number of repetitions was timed for one minute. ICC for test-retest reliability was 0.87 (95% confidence), and the CI is 0.635–0.959.

Physiological measures: - The stair run test, invented by Margeria Kalamen, is regarded as one of the most extensively used tests utilized for evaluating AP. ICC for test-retest reliability was 0.98 (95% confidence), and the CI is 0.963–0.996. The VC was determined using a spirometer and quantified in litres. Each participant had three tries. The VC score was calculated by picking the best of three. Every time, the spirometer was properly examined in preparation for the next test of the participant. ICC for test-retest reliability was 0.95 (95% confidence), and the CI is 0.861–0.981. $VO_{2\ max}$ was measured by the Queens College Step Test, a widely used test for determining $VO_{2\ max}$. ICC for test-retest reliability was 0.96 (95% confidence), and the CI is 0.909–0.990.

Statistical analysis

The researcher was responsible for the physically recorded data, which was then entered into a spreadsheet and examined for transcription problems. Quantitative measures were presented in the form of the mean and standard deviation (SD). In order to determine whether or not the outcome measure followed a normal distribution, the Shapiro–Wilk test was carried out. A normal distribution was observed for all the measures, and the p-value was greater than 0.05. The association between body mass, height, and BMI with all the biomotor and physiological measures were analyzed using Pearson product movement correlation (r). It was determined how the magnitude of the correlations (r) between the measures was interpreted. When 'r' was less than 0.1, it was considered to be trivial; 0.1 to 0.3, considered to be small; 0.3 to 0.5, considered to be moderate; 0.5 to 0.7, considered to be large; 0.7 and 0.9, considered to be very large; and 0.9 to 1.0, considered to be almost perfect [23]. A one-way analysis of variance was used to test the difference between three different playing positions (defenders, midfielders, and forwards). Additionally, for the analysis of variance (ANOVA), the effect size was determined by utilizing the eta square (η2), where 0.01 represents a small effect, 0.06 represents a medium effect, and 0.13 represents a large effect [24]. For the purpose of identifying differences between defenders and midfielders, midfielders and forwards, and defenders and forwards, the Tukey post hoc test was utilized throughout the study [25]. The effect size was determined for the post hoc test by utilizing Cohen's d values and establishing three cut-off points: a low effect of 0.20, a medium effect of 0.50, and a large effect of 0.80 [26]. All the statistical analyses were tested using the IBM 22 SPSS version.

Results

Table 1 demonstrates the Shapiro-Wilks normality test of the anthropometric characteristics such as body mass, height, and BMI, as well as biomotor and physiological measures. Table 1 displays that all of the outcome measures were normally distributed (p-value greater than 0.05).

The descriptive statistics (mean and standard deviation (SD)) of all of the anthropometric characteristics, as well as the interclass correlation coefficients (ICC) of the biomotor and physiological measures, are presented in Table 2. All the intraclass correlation coefficients (ICC) of the biomotor and physiological measures are within the range of 0.87 to 0.98.

Pearson product-moment correlation coefficients for hockey players (n = 46) are displayed in Tables 3 to 5. Table 3 presents the correlations between the biomotor and physiological measures with the body mass of field hockey players. Some of the bio motor measures, such as speed (r=-.355, p<0.05) and COD (r=-.334, p<0.05), were shown to have a moderate negative correlation with body mass, whereas MS (r=.410, p<0.01) was found to have a moderate positive correlation with body mass. However, there was no association between a field hockey player's body mass and ME in the biomotor measures. In terms of physiological measures, VC (r=.390, p<0.01), AP (r=490, p<0.01), and $VO_{2\ max}$ (r=.301, p<0.05) were found to have a moderate positive correlation with body mass. The scatter plot that depicts the relationship between body mass and all of the biomotor and physiological measures involved in this research is shown in Figure 1.

Table 4 presents the correlations between the biomotor and physiological measures with the height of field hockey players. Some of the bio motor measures, such as speed (r=-.628, p<0.01) and COD (r=-.515, p<0.01), were shown to have

Table 1. **Normality test of all the outcome measures**

Outcome measures	**Shapiro-Wilk**		
	Statistic	**df**	**Sig.**
Body mass (kg)	0.982	46	0.672
Height (m)	0.960	46	0.117
BMI (kg /m²)	0.970	46	0.271
MS (kg)	0.973	46	0.348
Speed (S)	0.956	46	0.083
COD (S)	0.966	46	0.203
ME (N)	0.953	46	0.062
VC (L)	0.953	46	0.060
AP (W)	0.958	46	0.093
$VO_{2\ max}$ (ml/kg/min)	0.951	46	0.053

kg= kilograms, m= meters, S= seconds, N= numbers, L= liters, W=watts.

Table 2. **Descriptive statistics and interclass correlation coefficient of outcome measures**

		Mean	SD	ICC (95% CI)
Body mass (kg)	**Anthropometric characteristics**	63.87	5.23	-----
Height (m)		1.68	0.07	-----
BMI (kg /m²)		22.60	1.42	-----
MS (kg)	**Bio motor measures**	44.83	4.32	0.98 (0.943–0.993)
Speed (S)		7.32	0.36	0.95 (0.861–0.984)
COD (S)		18.29	0.89	0.98 (0.943–0.994)
ME (N)		40.15	2.48	0.87 (0.635–0.959)
VC (L)	**Physiological measures**	3.84	0.26	0.98 (0.963–0.996)
AP (W)		1085.63	106.42	0.95 (0.861–0.981)
$VO_{2\,max}$ (ml/kg/min)		39.20	2.56	0.96 (0.909–0.990)

ICC= Interclass correlation coefficient, kg= kilograms, m= meters, S= seconds, N= numbers, L= liters, W=watts.

Table 3. **Correlation with body mass and biomotor and physiological measures.**

Outcome measures	2	3	4	5	6	7	8	Mean (SD)
1. **Body mass** (kg)	.410**	-.355*	-.334*	.239	.390**	.490**	.301*	62.87(5.23)
2. **MS** (kg)		-.262	-.328*	.303*	.230	.202	.119	44.83(4.32)
3. **Speed** (S)			.729**	.028	-.052	-.250	.133	7.32(0.359)
4. **COD** (S)				-.023	-.133	-.152	.214	18.28(0.893)
5. **ME** (N)					-.131	.006	.320*	40.15(2.48)
6. **VC** (L)						.331*	.121	3.84(0.259)
7. **AP** (W)							-.212	1085.63(106.42)
8. **$VO_{2\,max}$** (ml/kg/min)								39.20(2.56)

**0.05 level of significance, **0.01 level of significance, kg= kilograms, m= meters, S= seconds, N= numbers, L= liters, W=watts.*

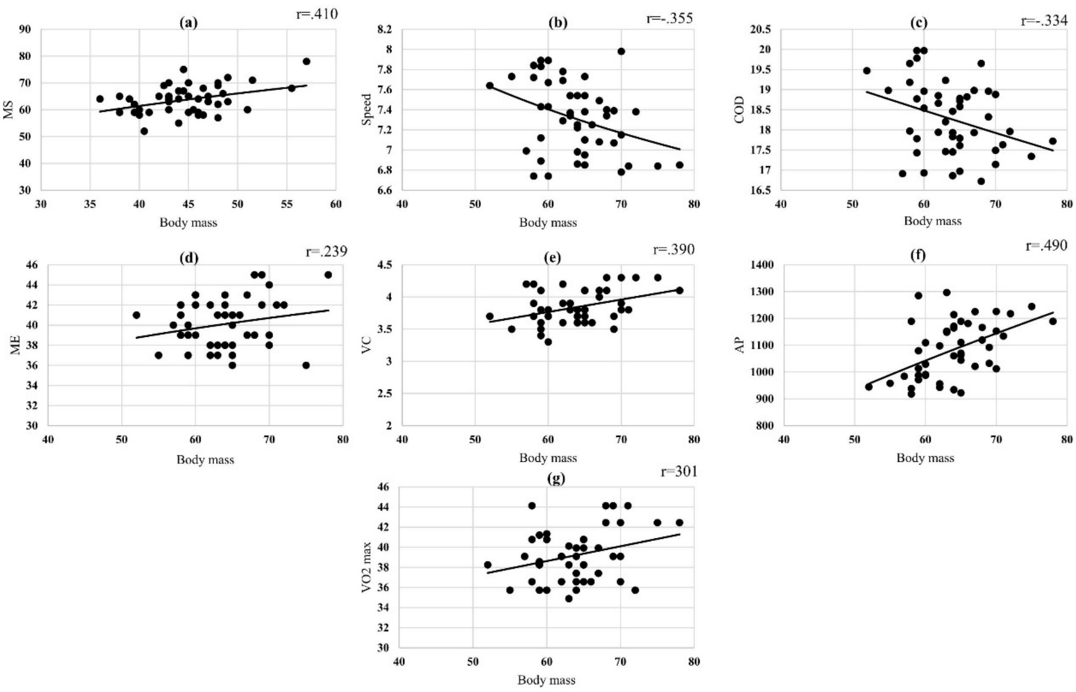

Figure 1. **Relationship between body mass and (a) MS, (b) speed, (c) COD, (d) ME, (e) VC, (f) AP, (g) $VO_{2\,max}$ among field hockey players.**

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Table 4. **Correlation with height and biomotor and physiological measures.**

Outcome measures	2	3	4	5	6	7	8	Mean (SD)
1. **Height** (m)	.383**	-.628**	-.515**	.203	.016	.350*	.006	1.68(0.070)
2. **MS** (kg)		-.262	-.328*	.303*	.230	.202	.119	44.83(4.32)
3. **Speed** (S)			.729**	.028	-.052	-.250	.133	7.32(0.359)
4. **COD** (S)				-.023	-.133	-.152	.214	18.28(0.893)
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8. **$VO_{2\,max}$** (ml/kg/min)								39.20(2.56)

*0.05 level of significance, **0.01 level of significance, *kg= kilograms, m= meters, S= seconds, N= numbers, L= liters, W=watts.*

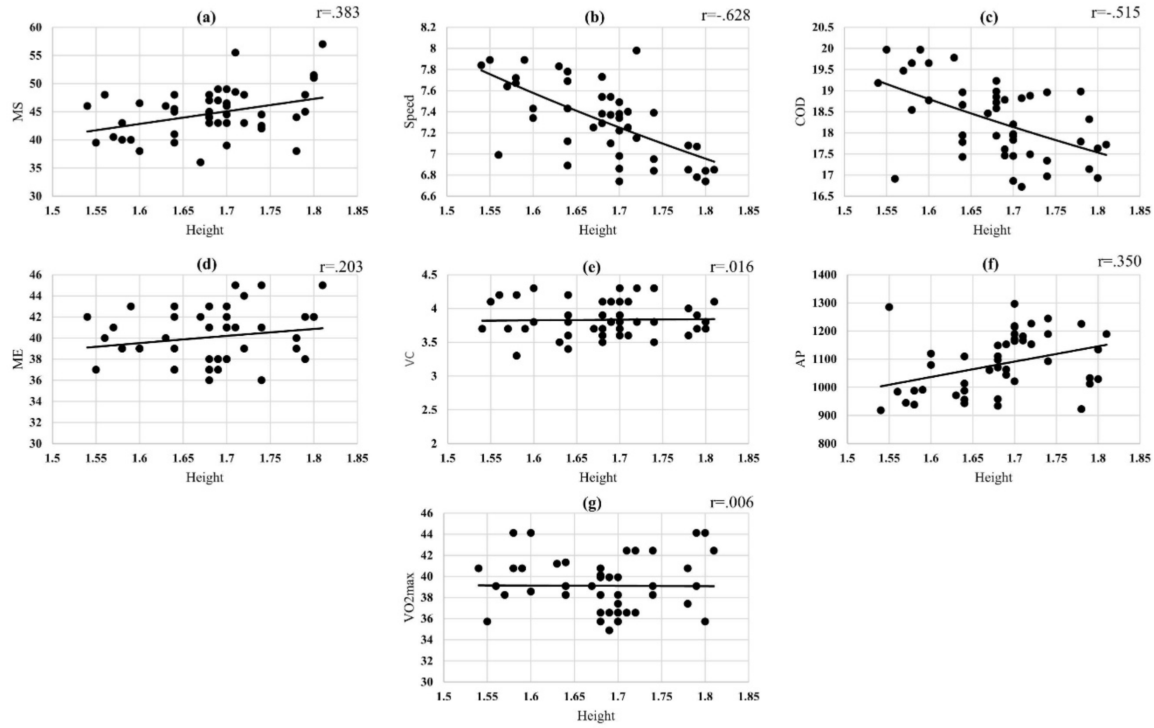

Figure 2. **Relationship between Height and (a) MS, (b) speed, (c) COD, (d) ME, (e) VC, (f) AP, (g) $VO_{2\,max}$ among field hockey players.**

a large negative correlation with height, whereas MS (r=.383, $p<0.01$) was found to have a moderate positive correlation with height. However, there was no association between a field hockey player's height and ME in the biomotor measures. In terms of physiological measures, AP (r=.350, $p<0.05$) were found to have a moderate positive correlation with height. However, in VC and $VO_{2\,max}$ there was no association between field hockey player's heights. The scatter plot that depicts the relationship between height and all of the biomotor and physiological measures involved in this research is shown in Figure 2.

Table 5 presents the correlations between the biomotor and physiological measures with the BMI of field hockey players. One of the bio motor measure, speed (r=.368, $p<0.05$), were shown to have a moderate positive correlation with BMI. However, there was no association between field hockey player's BMI with MS, speed, and ME in the biomotor measures. In terms of physiological measures, some of the measures, including VC (r=.479, $p<0.01$) and $VO_{2\,max}$ (r=.373, $p<0.05$) there, were found to have a moderate positive association between a field hockey player's BMI. However, AP was found to have no correlation with BMI. The scatter plot that depicts the relationship between BMI and all of the biomotor and physiological measures involved in this research is shown in Figure 3.

There are connections between some of the biomotor and some of the physiological measures of field hockey players, and these correlations are presented in Tables 3-5. It was shown that

Table 5. **Correlation with BMI and biomotor and physiological measures.**

Outcome measures	2	3	4	5	6	7	8	Mean (SD)
1. **BMI** (kg /m²)	.017	.368*	.253	.033	.479**	.163	.373*	22.60(1.42)
2. **MS** (kg)		-.262	-.328*	.303*	.230	.202	.119	44.83(4.32)
3. **Speed** (S)			.729**	.028	-.052	-.250	.133	7.32(0.359)
4. **COD** (S)				-.023	-.133	-.152	.214	18.28(0.893)
5. **ME** (N)					-.131	.006	.320*	40.15(2.48)
6. **VC** (L)						.331*	.121	3.84(0.259)
7. **AP** (W)							-.212	1085.63(106.42)
8. **$VO_{2\,max}$** (ml/kg/min)								39.20(2.56)

*0.05 level of significance, **0.01 level of significance, *kg= kilograms, m= meters, S= seconds, N= numbers, L= liters, W=watts.*

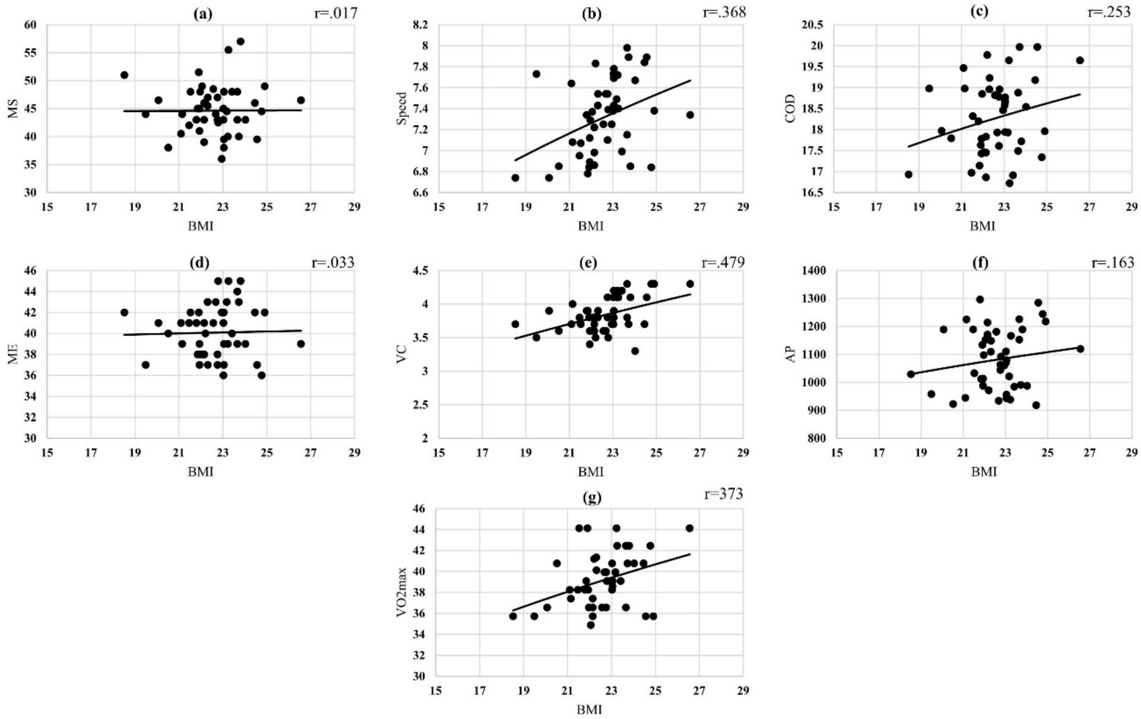

Figure 3. **Relationship between BMI and (a) MS, (b) speed, (c) COD, (d) ME, (e) VC, (f) AP, (g) $VO_{2\,max}$ among field hockey players.**

there was a negative correlation between muscle strength and COD (r=-.328, p<0.05), with a moderate effect. The correlation between MS and ME was shown to be positive (r=.303, p<0.05), with a moderate effect. There was a significant positive correlation between speed and COD (r=.729, p<0.01), indicating a very large effect. The correlation between ME and $VO_{2\,max}$ was shown to be positive (r=.320, p<0.05), with a moderate effect. The correlation between VC and AP was found to be positive (r=.331, p<0.05), with a moderate effect.

Table 6 displays the results of a one-way analysis of variance (ANOVA) that showed that there was no significant difference between the three playing positions (defenders, midfielders, and forwards) in terms of any of the biomotor and physiological measures, as well as body mass, height, and BMI. However, when the effect size was evaluated using eta square, the COD was found to have a small effect size. Body mass, height, and some of the measures in bio motor measures such as MS, speed, and ME, as well as some of the measures in physiological measures such as AP and $VO_{2\,max}$, were found to have a moderate effect size. On the other hand, the BMI and the VC were found to have a large effect size.

Figure 4 displays the results of Tukey post hoc comparison that showed that there was no significant difference between the three playing positions (defenders vs midfielders, midfielders vs forwards, and defenders vs forwards) in terms of any of the biomotor and physiological measures, as well as body mass, height, and BMI. However,

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Table 6. **Comparison of anthropometric characteristics, bio motor and physiological measures between three playing positions.**

Outcome measures	Defenders (10)	Midfielders (16)	Forwards (20)	f	p	η_2
	Mean (SD)	Mean (SD)	Mean (SD)			
Body mass (kg)	65.10(4.63)	64.50(6.13)	62.75(4.75)	0.844	0.437	0.038
Height (m)	1.71(0.068)	1.67(0.070)	1.67(0.071)	1.064	0.354	0.047
BMI (kg /m²)	22.31(1.72)	23.08(1.58)	22.36(1.10)	1.435	0.249	0.063
MS (kg)	44.25(3.85)	45.75(4.32)	44.37(4.62)	0.552	0.580	0.025
Speed (S)	7.21(0.349)	7.36(0.354)	7.34(0.373)	0.628	0.538	0.028
COD (S)	18.17(0.753)	18.37(0.866)	18.27(1.01)	0.149	0.862	0.007
ME (N)	39.20(2.25)	40.56(2.34)	40.30(2.70)	0.987	0.381	0.044
VC (L)	3.82(0.282)	3.96(0.242)	3.76(0.239)	2.789	0.078	0.115
AP (W)	1113.39(106.07)	1080.27(106.62)	1076.05(109.51)	0.430	0.653	0.020
$VO_{2\ max}$ (ml/kg/min)	38.84(2.06)	38.88(2.36)	39.63(2.6)	0.492	0.615	0.022

η_2=Eta square, SD= Standard deviation, kg= kilograms, m= meters, S= seconds, N= numbers, L= liters, W=watts.

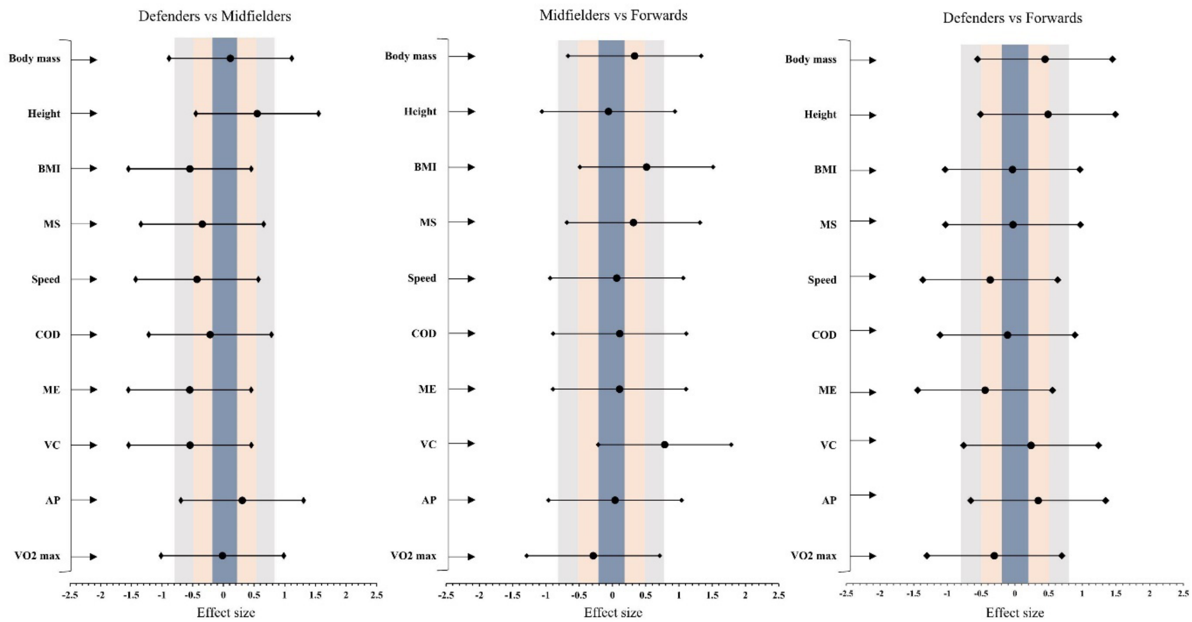

Figure 4. **Post hoc comparison of Body mass, height, BMI, and biomotor and physiological measures in testing data based on playing position (Differences are shown as effect sizes).**

when the effect size was calculated using Cohen's d, the comparison between defenders and midfielders body mass and physiological measure $VO_{2\ max}$ had a small effect size, but MS, speed, and COD in biomotor measures and physiological measure AP had a medium effect size. Height, BMI, biomotor measure ME, and physiological measure VC all exhibited large effect sizes. The comparison of midfielders and forwards height and biomotor measures speed, COD, and ME, as well as physiological measure AP, had a small effect size. Body mass and biomotor measure MS and the physiological measure $VO_{2\ max}$ shown to have a medium effect size. BMI and physiological measure VC exhibited a large effect size. The comparison of defenders and forwards' BMI and biomotor measures MS and COD showed a small effect size, but body mass, height, biomotor measures speed, ME, and all physiological measures such as VC, AP, and $VO_{2\ max}$ had a medium effect size.

Discussion

The field hockey players height (168.0±0.7 cm), body mass (63.87±5.23 kg), and BMI

(22.60±1.42) were all within the range that has been observed in prior research on professional and national hockey players (height: 169.12±5.73 cm, body mass: 63±7.8 kg, and BMI:22.9±1.3) [11,22]. The results of the current study reveal that some of the biomotor parameters, such as speed and COD, have a moderate negative association with body mass, but MS has a moderate positive correlation with body mass. However, there was no correlation between a hockey player's body mass and ME in the biomotor measures. In terms of physiological parameters, all measures, including VC, AP, and $VO_{2\,max}$, showed a moderate relationship with body mass. Some of the previous studies are in line with current study results [18,22,27–30]. Based on the study by Sharma et al., (2012) determined that weight and body fat percentage had statistically significant positive connections with lower limb power and handgrip strength and associations with slalom sprint, aerobic fitness, and the dribbling test among those anthropometric parameters. The findings of Charushila et al., (2018) indicate that there is a favourable link between the strength of individuals' MS and their height and weight among cricket players. Wong et al., (2009) explore that sprint time was shown to have a strong correlation with body mass. According to the findings of Brahim et al., (2013), the most important indicators of the young soccer players' 20-meter sprint time and the Yo-Yo intermittent endurance test distance were their weight and height. $VO_{2\,max}$ and VC were shown to have a substantial association with body weight, according to the findings of Mohammed et al., (2016). It is suggested by Maciejczyk et al., (2015) that the composition of the body, which includes the mass of the body, is a significant factor in determining the AP of cycling athletes. In light of this, body mass is repositioned as an essential component of speed. Bejan and Marden's Constructal theory, which argues that speed enhances with body mass, is supported by these findings, which align with the hypothesis [31]. The requirement of muscle strength, ground force, and power, are all factors which contribute to the increased efficiency that is linked with possessing a higher body mass with speed [21].

The findings of the current study determined that some of the biomotor measures, such as speed and COD, have a strong negative association with height. One of the previous studies has shown that speed had a negative correlation with height [32], which is in line with the current study result on speed. Although MS has a moderate positive correlation with height, there was no correlation between height and ME in the biomotor measures. In terms of physiological measures, one of the measures, AP, was discovered to have a moderately favourable connection with height. In contrast, height had no effect on VC or $VO_{2\,max}$. Some of the previous studies have been in line with the findings of the present study [27,33–35]. The findings of Gunnar Mathisen & Pettersen, (2015) indicate that there is a substantial correlation between sprint performance and both height and body mass in anthropometric measures. According to Wong et al., (2009), body height was shown to have a strong correlation with the sprint timings of 10 meters and 30 meters. Schons et al., (2023) suggest that there is a negative correlation between COD and body composition, which indicates that body weight and height are included in this category. Boraczyński et al., (2017) suggest that among the groups of elite post-pubertal and mature male taekwondo athletes, it was revealed that there was a significant association between body height and maximal power output. Body height may increase the number and length of muscle fibres [36]. This may be the reason for getting a favourable link between height and handgrip strength in this present study.

The findings of the current study indicate that one of the biomotor measures, such as speed, has a moderate positive connection with BMI. However, no relationship was found between hockey player's BMI and their MS, COD, and ME in the biomotor measures. In terms of physiological features, some of the measures, such as VC and $VO_{2\,max}$, showed a moderate positive correlation with hockey player's BMI. However, there was no significant link between AP and BMI. Some of the previous studies have been in line with the findings of the present study [12,19,27,37]. The BMI was shown to have a strong correlation with the 30m sprint time, the Yo-Yo intermittent endurance run distance, as well as the maximum oxygen consumption ($VO_{2\,max}$) in youth football players [27]. In the case of young football players, BMI has been shown to have a weak association with endurance, as suggested by Leão et al., (2022). Kim et al., (2019) indicate that there was a substantial association between BMI and lung function. According to Dharmajayanti et al., (2023), there is a negative correlation between BMI and speed in athletes. The significant positive relationship between weight and BMI with physiological parameters like VC and maximum oxygen consumption can be explained by the role of body mass in enhancing respiratory and cardiovascular efficiency. Higher body weight, especially when it includes muscle mass, increases the body's demand for oxygen, leading to greater lung capacity and oxygen consumption [38]. A higher BMI, reflecting increased body size, may also contribute to larger lung volumes and improved cardiovascular function [39]. Y. Chen et al., (2007) suggest that BMI was found to have a positive correlation with respiratory functions, which included forced vital capacity, in participants of normal weight. These factors collectively support the current study, highlighting how body composition can positively influence physiological performance.

The current study's findings indicate a moderately negative association between MS and COD. The link between MS and ME has shown to be positive, with a moderate effect. A strong positive association was found between speed and COD, indicating a very large influence. The connection between ME and $VO_{2\ max}$ has shown to be positive, with moderate effects. The association between VC and AP has shown to be positive, with a moderate effect. Few previous research findings correspond with the present study's findings [40–42]. Research by Vescovi & McGuigan, (2008) shows that linear sprint times in high school and college soccer players were correlated with Illinois and Pro-Agility tests. According to the findings of the study conducted by Vaara et al., (2012), the maximal strength index correlated with the maximal strength of both the upper and lower extremities, and the level of ME index was closely associated with the maximum oxygen consumption ($VO_{2\ max}$). Based on the findings of the research conducted by Aurélio et al. (2016), the link between agility and speed was positive, while the association between agility and hand grip was found to be negative. The fact that the length of running speed at 50 meters and the duration of COD tests are comparable is one of the probable explanations for the current study result. Athletes need to be able to efficiently accelerate across short distances in order to achieve a larger speed in a shorter amount of time. This might result in the study participants performing with a substantial amount of force to the ground in order to be able to conquer the total moment of inertia [43]COD deficit, linear sprint speed, sprint momentum, and loaded and unloaded vertical jump performances in forty-nine male professional soccer players (24.3 ± 4.2 years; 75.4 ± 5.4 kg; 177.9 ± 6.4 cm.

The current study's findings show that there is no significant difference between the three playing positions in terms of biomotor and physiological measures, as well as anthropometric characteristics. Some of the previous research on hockey players and other populations has supported the findings of the current study [27,40,44]. The study by Shyamal et al. (2017) suggests that anthropometric and performance parameters did not significantly differ based on playing position in the context of female hockey players. According to the findings of Aurélio et al., (2016), there were no notable variations in body height, speed, agility, or endurance between the playing positions in their study of young football players. There are no significant positional changes in the physiological performances of youth football players, according to the findings of Wong et al., (2009), which imply that the sprint tests are not affected by positional differences. The modern game of hockey is characterized by positional fluidity, in which players regularly alter roles while the game is in progress [45]. As a result of this interchangeability, the physical and physiological features that are traditionally linked with particular positional roles can be blended together, resulting in a group that is more similar to one another. In addition, the administration of training loads by coaches in a consistent manner across all positions has the potential to contribute to physiological adaptations that are comparable across players, independent of the duties that they are assigned specifically on the field [46]. It is possible that these elements are responsible for the fact that this study did not find any significant differences in bio motor, physiological, and anthropometric features between defenders, half-backs, and forwards.

The study's limitations include its relatively small sample size, especially in positional subgroups, which may limit the generalisability of the findings to a larger population of hockey players; additionally, the cross-sectional design only offers a snapshot of the relationships between anthropometric characteristics and performance measures, without looking at changes over time or the effects of training interventions; and lastly, it failed to account for potential confounding variables such as diet, hydration status, recovery protocols, or psychological factors, which may influence bio-motor and physiological performance. Future studies with larger sample sizes and longitudinal designs may offer more robust insights.

Conclusion

Overall, the results conclude that body mass has a considerable impact on performance, with a moderate negative association with speed and COD. However, increasing body mass has a positive association with MS and physiological measures. Height also had an impact, with a strong negative association with speed and COD and a moderate positive correlation with MS and AP. BMI was moderately related to endurance capacity, such as VC and $VO_{2\ max}$, but had little impact on other physical measures, such as speed. On the other hand, muscle strength had a moderate negative correlation with COD, a positive correlation with ME, a significant very large positive correlation between speed and COD, a positive correlation between ME and $VO_{2\ max}$, and a positive correlation between VC and AP, all of which had moderate effects on the physiological measures of field hockey players. Finally, there were no significant differences across positions. Anthropometric characteristics such as body mass, height, and

BMI are important in impacting performance. The study advised that training regimens for hockey players prioritize optimizing body mass, height, and BMI in order to bring about improvements in performance results. This recommendation is based on the findings. A further advantage is that it enables more generalized training techniques to be used across the team.

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Supplementary Information

Article details

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