Discriminating Anthropometric Characteristics of Malaysian Youth Handball Players

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Abstract: ***This study aimed to determine the morphological profile among youth handball players based on anthropometric measurements and identify the most significant variables that differentiated the players. The samples of 156 male and 157 female were obtained among Malaysian youth handball players, and its main tributaries were evaluated for anthropometric measurements (body weight, standing height, body mass index, leg length and arm span). Multivariate methods of Hierarchical Agglomerative Cluster Analysis (HACA) and Discriminant Analysis (DA) were used to determine the groups and studied the variations of the most significant anthropometric variables. Three clusters of morphological characteristics (BS1, BS2 and BS3) in handball were shaped in view by HACA for male and female players. HACA assigned 41, 83 and 32 male players in BS1, BS2 and BS3 clusters, respectively. Meanwhile, a total of 63, 79 and 13 female players were assigned in BS1, BS2 and BS3 clusters, respectively. For male players, the percentage of classification correctness using standard mode is 97.44% with five significant variables (body weight, standing height, body mass index, leg length and armspan). Forward stepwise DA revealed 96.79% correctness with only two significant variables (body weight and arm span), while backward stepwise DA revealed 97.44% classification correctness with four significant variables out of five by removing leg length parameter. For female players, the classification correctness using standard mode is 93.63% with five significant (body weight, standing height, body mass index, leg length and armspan). Forward stepwise DA revealed 94.27% correctness with only two significant variables (body weight and arm span), while backward stepwise DA revealed 93.63% classification correctness with four significant variables out of five by removing also leg length parameter. Information on the physical characteristics of players can help coaches appointed the appropriate position according to their morphological profile category. This approach, in the long run, is beneficial to reduce the time, save manpower and make decisions scientifically.***

Keyword: Morphology, Clustering, Discriminating, Youth Handball Players

1. INTRODUCTION

There is an increasing notion that individuals competing in sports and to a certain extent, playing positions, require specific physical and physiological attributes. Apart from the technical and psychological parameters, the anthropometric characteristics of an individual have become an increasing important variable that could affect his or her performance in a particular sport. Norton and Olds (2001) reviewed the anthropometric data of professional basketball and American Football players and found that players who were taller and heavier had longer playing career compared to those who were shorter and lighter. Each sport requires a unique set of physical attributes (e.g., height, weight, limb length) as they are related to the biomechanical and physiological aspects of the movements needed. Although height and limbs length are genetically determined, these endowment can be enhanced when complemented with sport specific physiological and technical demands (Bouchard & Lortie, 1984). These combinations would increase the effectiveness of training and development of an individual identified for a particular sport.

Studying the morphological profiles of athletes enables the understanding the variance among individuals and serve as a method to identify the physical characteristics suited for a particular sport. Extensive studies have been published on Olympic athletes' body structure (for a review, see (Hawes & Sovak, 1994)). This information may serve as guide to identify future athletes. Data from such studies relied primarily on traditional methods of anthropometry measurement, which may differ and varied. With the guidelines set by organisations such as the International Society for the Advancement of Kinanthropometry (Marfell-Jones, Stewart, & de Ridder, 2012), the validity and reliability of the measurements have been standardised. Of recent, researchers have begun applying mathematical and statistical models into this area of study (Yusoff et al., 2019; Mat-Rasid et al., 2019; Maliki et al., 2018). For example, Mat-Rasid and colleagues (2019) applied multidimensional analysis assessing the anthropometric and physical fitness profiles of 600 adolescents selected for a sport identification programme. The study found weight, sitting height and arm span as significant anthropometric attributes for identifying talented athletes in sport. However, the limitation of the studies was they examined participants who have not achieved high performance level (i.e., national level), which may affect the strength of its results on identifying elite youth athletes.

A study applying multivariate analyses on elite men handball players showed a mesomorph body type, tall stature and optimal skeletal and muscle mass proportion (Srhoj, Marinović, & Rogulj, 2002). The study further examined the anthropometric properties of the players according to playing position and found the back court players and goalkeepers were bigger and heavier compared to the forward positions (i.e., wings and pivot). Wings were found to be taller and lighter although the position of pivots was the heaviest compared to all playing positions. The results from this study largely supported the findings from a later study on the men's handball world championship (Ghobadi et al., 2013). The back court players were the tallest when compared with other positions. However, the wings were lighter and shorter while players in the pivot position were significantly heavier. The authors suggest that the anthropometric properties of the wings enabled them to sprint on fast break and retreat quickly to defend the perimeter. Data from both studies (Srhoj et al., 2002; Ghobadi et al., 2013) however were collected from adult male players and largely from the European continent. Limited information is available on Asian players and especially among the youth players. Handball is a team sport and it is competed at both amateur and professional level. The sport was introduced at the Olympics since 1972 (Ghobadi et al., 2013). In Malaysia,

handball has been included as a sport in the Malaysian Schools Sports Council (MSSM) programme (Husni Hassan et al., 2016; Ong & Ahmadi, 2015). It is competed at the national level, involving teams from 14 states and the age group comprises of under 12 and under 18 categories for male and female.

The purpose of this study was to apply a multidimensional analysis to determine the relative anthropometric characteristics of MSSM handball players that could discriminate their playing positions. The employed hypotheses of this study is playing position-specific characteristics of anthropometric in handball players can be recognized significantly of body weight, height, body mass index, leg length and armspan.

2. RESEARCH METHODS

2.1. Participants

The data in this study was obtained from Malaysian youth handball players who participated in the Malaysian Schools Sports Council (MSSM) Handball Tournament 2019. They consisted of 156 male players (aged 16.6±0.7 years) and 157 female players (aged 15.9±1.2 years). All participants were informed of the study and consent was obtained from their parents and coaches prior to the commencement in this study.

2.2. Anthropometric Measurements

The participants underwent anthropometric measurements which comprised of body weight, standing height, body mass index (weight in kilograms divided by the squared of height in meters), sitting height (to measure leg length through total height minus sitting height) and arm span. Body weight was measured using a portable weighing scale (ADE, Germany) to the nearest 0.1kg with participants dressed in light clothing. Standing height and sitting height are measured using a stadiometer (Seca, Hamburg, Germany) to the nearest 0.1cm. Arm span is measured using measurement tape and data is recorded nearest to 0.1cm. All the measurements were taken following the ISAK protocol (Marfell-Jones, Stewart, & de Ridder, 2012).

2.3. Statistical Analysis

Pre-processing data: A matrix set of the male players contained 936 matrices data (6 variables × 156 players) while matrix set of female players contained 942 matrices data (6 variables × 157 players) were computed in this study. Before performing the main analysis in this study, all missing data and outliers were examined then followed by checking the normalization of the data (Yusoff et al., 2019).

Hierarchical Agglomerative Cluster Analysis (HACA): In this study, HACA was employed to identify the clusters of body physical among handball players. HACA is a robust method to identify and categorize components or subjects (observations/population) into clusters with greater homogeneity state within the class and greater heterogeneity state among classes with regard to a predetermined selection criterion (Mat-Rasid et al., 2019). Moreover, Ward's technique utilizing Euclidean distances as a degree of resemblance in HACA has shown to be a very effective technique. HACA assigns the clusters and their closeness through clarification by a dendrogram.

Discriminant Analysis (DA): DA is a statistical method that can be used in explanatory or predictive frameworks to check if the groups to which observations belong are distinct (Maliki et al., 2018). Besides standard model DA is used, this study also applies forward and backward stepwise method. Forward stepwise process starts by adding the variable with the largest contribution to the model. If a second variable is such that its entry probability is greater than the entry threshold value, then it is added to the model. After the third variable is added, the impact of removing each variable present in the model after it has been added is evaluated. If the probability of the calculated statistic is greater than the removal threshold value, the variable is removed from the model. Backward stepwise method is similar to the previous one but starts from a complete model.

3. RESULTS AND DISCUSSION

Table 1 exhibits the descriptive statistics of the anthropometric measurement of U18 handball players. It shows the total number of players for male (N=156) and female (N=157). The minimum and maximum measurements, mean and standard deviations also were projected.

Table 1: Descriptive statistic of anthropometric measurement for Malaysian handball players.

Variables	Male (N=156)				Female (N=157)			
	Min	Max	Mean	SD	Min	Max	Mean	SD
Body Weight (kg)	49.4	118.0	67.4	13.3	39.5	97.4	57.1	10.4
Standing Height (cm)	158.6	191.4	172.6	5.9	146.0	173.2	159.0	4.9
Body Mass Index (kg/m^2)	16.3	38.2	22.6	4.0	16.0	39.8	22.6	3.8
Leg Length (cm)	72.7	93.7	81.9	4.1	65.6	82.1	74.4	3.3
Arm Span (cm)	157.7	199.0	177.0	6.9	147.0	178.5	161.6	6.1

Figure 1 shows the dendrogram of morphological profile clusters determined by HACA, which is based on the resemblance anthropometric measurements. For the male players, HACA assigned 41(26.3%) players in BS1, 83(53.2%) in BS2 and 32(20.5%) players in BS3. Meanwhile, for female players, a total of 65(41.4%), 79(50.3%) and 13(8.3%) players were assigned in BS1, BS2 and BS3 clusters, respectively.

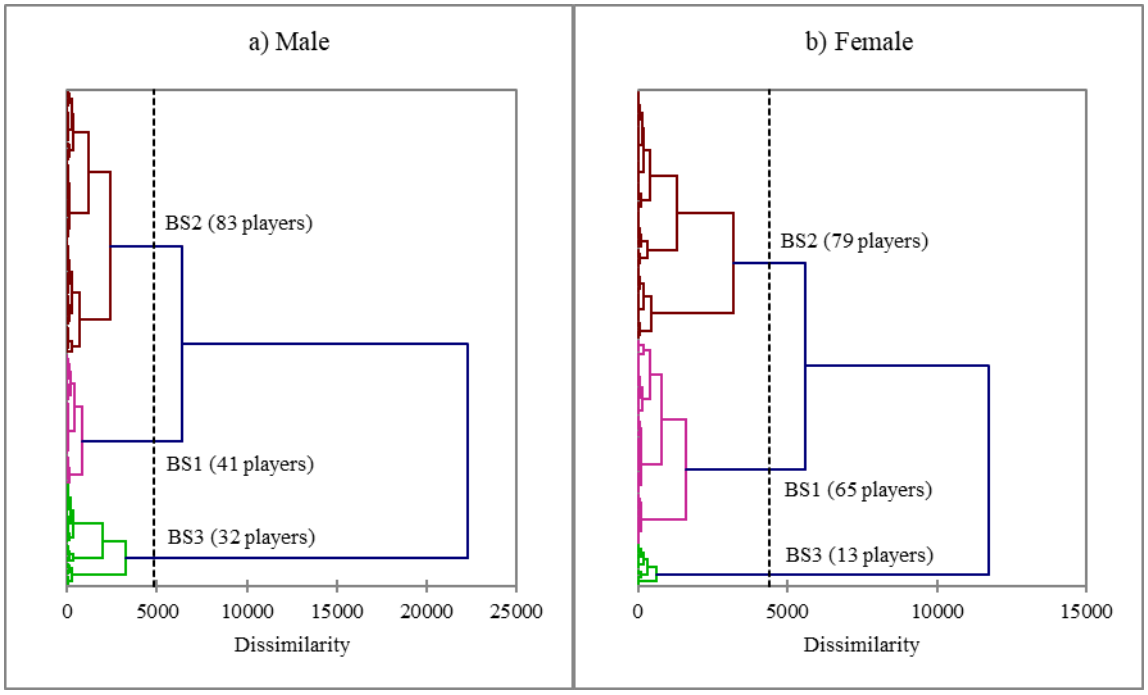

Figure 1: Dendrogram for different clusters of morphological profile among handball players

Figure 2 and Figure 3 show the boxplot of morphological profile characteristics for BS1, BS2 and BS3. As a summary, the characteristics of anthropometric for BS1 cluster have mean and standard deviation of body weight (56.1±3.8kg), standing height (166.6±3.5cm), body mass index (20.3±1.6kg/m^2), leg length (78.7±3.1cm) and arm span (169.5±4.0cm). Boxplot also observed the characteristics of anthropometric for BS2 cluster have mean and standard deviation of body weight (64.6 ± 4.9kg), standing height (173.9±4.3cm), body mass index (21.4±2.1kg/m^2), leg length (83.0±3.5cm) and arm span (178.8±5.2cm). Finally, the characteristics of anthropometric for BS3 cluster have mean and standard deviation of body weight (64.6 ± 4.9kg), standing height (176.6±6.2cm), body mass index (28.6±3.8kg/m^2), leg length (83.3±4.2cm) and arm span (181.8±6.0cm). Overall, their leg length and arm span increased correspondingly with body weight, standing height and body mass index.

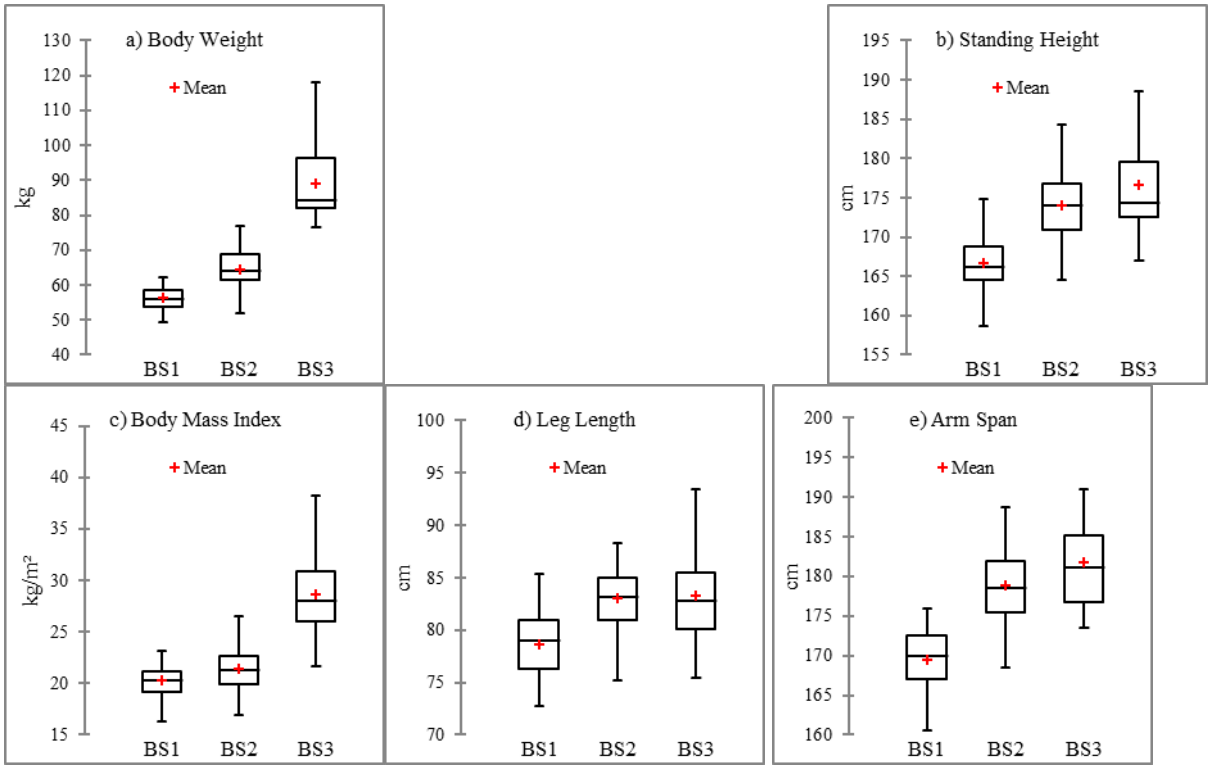

Figure 2: Boxplot of anthropometric characteristics according clusters assigned by HACA for male players

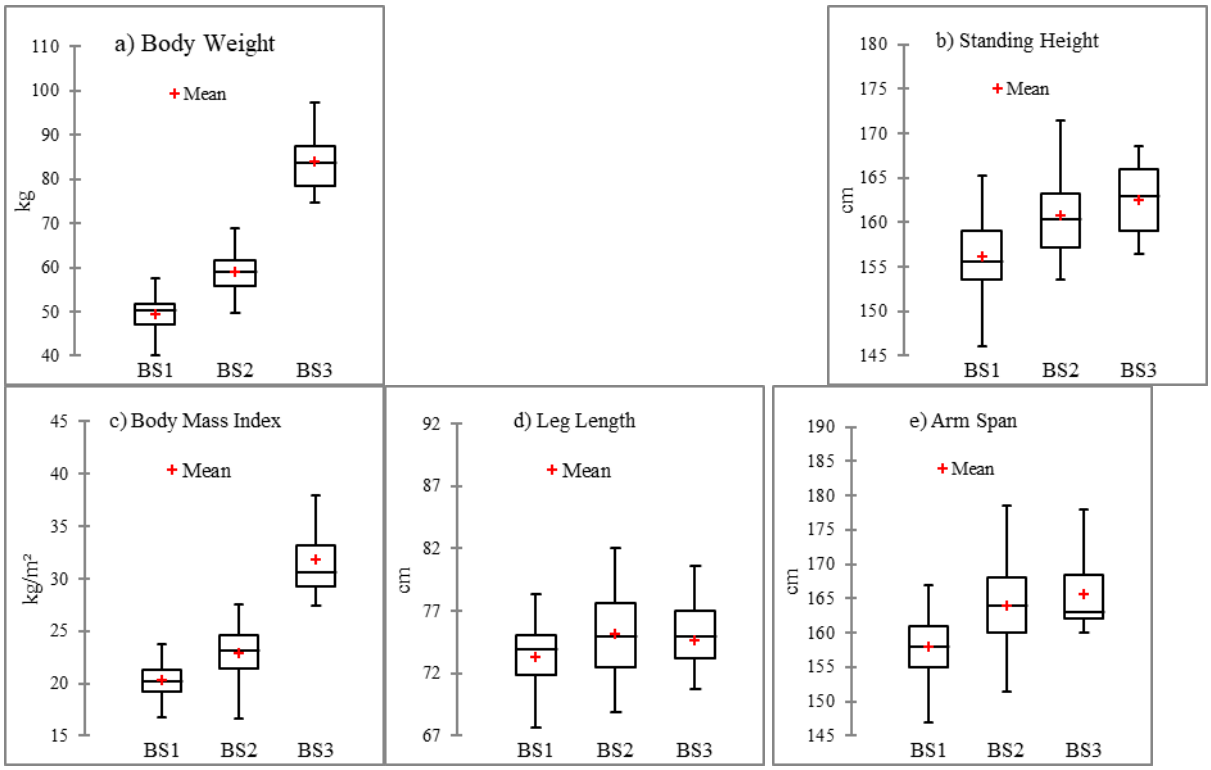

Figure 3: Boxplot of anthropometric characteristics according clusters assigned by HACA for female /players

Table 2 shows the contingency table between BS1, BS2 and BS3 clusters in relation with the playing positions of the players according to gender. The finding shows majority of the handball goalkeepers were assigned in BS3 cluster with heavier body weight, taller stature,

greater body mass index, longer leg length and arm span than other positions. The table also observed that majority of players in the centre, pivot and back court position were categorized in BS2 cluster with heavier body weight, taller stature, greater body mass index, longer leg length and arm span compared to the wing positions. Majority of players in wing position were assigned in BS1 cluster. An interesting finding from this study was the clusters showed similarity composition with both genders.

Table 2: Contigency table between of clusters and player's position in handball

Clusters	Goalkeeper		Centre		Pivot		Back Court		Wing	
	No.	%	No.	%	No.	%	No.	%	No.	%
Male										
BS1	5	19.2	8	32.0	5	21.7	7	16.3	21	53.8
BS2	6	23.1	11	44.0	14	60.9	31	72.1	16	41.0
BS3	15	57.7	6	24.0	4	17.4	5	11.6	2	5.1
Total	**26**	**100.0**	**25**	**100.0**	**29**	**100.0**	**14**	**100.0**	**20**	**100.0**
Female										
BS1	5	18.5	9	40.9	9	45.0	14	30.4	28	66.7
BS2	6	22.2	10	45.5	9	45.0	30	65.2	14	33.3
BS3	16	59.3	3	13.6	2	10.0	2	4.3	0	0.0
Total	**27**	**100.0**	**22**	**100.0**	**27**	**100.0**	**19**	**100.0**	**19**	**100.0**

Table 3 shows the discriminant analysis conducted for the further analysis. The DA was applied to clusters defined by HACA in order to look through variation of morphological profile. The clusters were treated as the dependent variable, whereas anthropometric parameters were treated as independent variables. Table 3 and Table 4 show the significant variables and percentage of classification correctness using standard, forward and backward stepwise mode of DA, respectively. For male players, the correctness of classification using standard mode is 97.44% with five significant (body weight, standing height, body mass index, leg length and armspan). Forward stepwise DA revealed 96.79% correctness with only two significant variables (body weight and arm span), while backward stepwise DA revealed 97.44% classification correctness with four significant variables out of five by excluding leg length parameter. For female players, the classification correctness using standard mode is 93.63% with five significant (body weight, standing height, body mass index, leg length and armspan). Forward stepwise DA revealed 94.27% correctness with only two significant variables (body weight and arm span), while backward stepwise DA revealed 93.63% classification correctness with four significant variables out of five by excluding also leg length parameter. From the DA result, a coach may reduce the parameters by selecting the most significant parameters to differentiate player's body size category. This approach may help coaches in the future in reducing the duration and manpower for selecting the correct players.

Table 3: Unidimensional test of equality of the means of the classes from Discriminant Analysis

Mode of DA	Variables	Male			Female		
		Lambda	F	p-value	Lambda	F	p-value
Standard	BW	0.235	248.624	< **0.0001**	0.207	294.453	< **0.0001**
	SH	0.597	51.713	<	0.761	24.226	<

				0.0001			**0.0001**
	BMI	0.375	127.543	**<0.0001**	0.359	137.418	**<0.0001**
	LL	0.766	23.331	**<0.0001**	0.924	6.373	**0.002**
	AS	0.546	63.600	**<0.0001**	0.744	26.481	**<0.0001**
Forward (stepwise)	BW	0.235	248.624	**<0.0001**	0.207	294.453	**<0.0001**
	SH						
	BMI						
	LL						
	AS	0.546	63.600	**<0.0001**	0.744	26.481	**<0.0001**
Backward (stepwise)	BW	0.235	248.624	**<0.0001**	0.207	294.453	**<0.0001**
	SH	0.597	51.713	**<0.0001**	0.761	24.226	**<0.0001**
	BMI	0.375	127.543	**<0.0001**	0.359	137.418	**<0.0001**
	LL						
	AS	0.546	63.600	**<0.0001**	0.744	26.481	**<0.0001**

BW=Body Weight, SH=Standing Height, BMI=Body Mass Index, LL=Leg Length, AS=Arm Span.

Table 4: Classification matrix of Discriminant Analysis (DA) for the anthropometric variations on the three different body physical clusters

Gender	from \ to	BS1	BS2	BS3	Total	% correctness
	Standard mode (5 significant variables)					
	BS1	39	2	0	41	95.12%
	BS2	0	83	0	83	100.00%
	BS3	0	2	30	32	93.75%
	Total	**39**	**87**	**30**	**156**	**97.44%**
	Forward stepwise (2 significant variables)					
	BS1	39	2	0	41	95.12%
Male	BS2	1	82	0	83	98.80%
	BS3	0	2	30	32	93.75%
	Total	**40**	**86**	**30**	**156**	**96.79%**
	Backward stepwise (4 significant variables)					
	BS1	39	2	0	41	95.12%
	BS2	0	83	0	83	100.00%
	BS3	0	2	30	32	93.75%
	Total	**39**	**87**	**30**	**156**	**97.44%**
	Standard mode (5 significant variables)					
	BS1	75	4	0	79	94.94%
Female	BS2	6	59	0	65	90.77%
	BS3	0	0	13	13	100.00%
	Total	**81**	**63**	**13**	**157**	**93.63%**

Forward stepwise (2 significant variables)					
BS1	61	4	0	65	93.85%
BS2	5	74	0	79	93.67%
BS3	0	0	13	13	100.00%
Total	**66**	**78**	**13**	**157**	**94.27%**
Backward stepwise (4 significant variables)					
BS1	60	5	0	65	92.31%
BS2	4	74	1	79	93.67%
BS3	0	0	13	13	100.00%
Total	**64**	**79**	**14**	**157**	**93.63%**

This study aimed to identify the morphogical and anthropometric characteristics that could discriminate the players according to their playing positions in handball. From the selected anthropometric measurements, the pivots and left/right backs were taller than the peripheral wings. These findings corresponded with previous studies that observed that wings were smaller than back court players (Srhoj et al., 2002; Sporiš et al., 2010). The variations between playing positions was most significant between the back court and wing attackers. We suggest that players selected to play the wings were more for tactical reasons as they would be able to sprint faster due to their physique when their team makes a fast break. Conversely, the back court players were more mesomorphic and heavier as these characteristics enabled them to block and defend the opponents from scoring as most of the scoring attempts are from the centre of the court and vice versa (Srhoj et al., 2002). Although there are different positions in handball, all except the goalkeeper will attack and defend in unison. This strategy is similar to basketball. Several studies agreed that the physiological demands of the backcourt players and/or pivot players were higher than the other positions as they recorded higher heart rate during matches (Michalsik, Madsen, & Aagaard, 2015; Póvoas et al., 2014). Furthermore, players with such body makeup would be essential due to the workload and intensity of activities that are usually concentrated in front of the goal area. In fact, the back court position is the most complex one of all the positions (Gontarev et al., 2017). During the match-play, they possessed the ball for the most of the time and their responsibility for both the organization of defence as well as attack. These players also most frequently shoot from the distant (around 6-9m from the goal). Greater longitudinal dimensions and longer levers are important because they assist in producing powerful and efficient throws at the goal over and through the defensive wall. Further, the taller backs have better visual control over the court and position of players on it. Their stature's advantage provide efficient co-operation (by passing) with the line players (pivots and wings). Wing players differed from the pivots, backcourt players and goalkeepers in their morphology (Arifi, Bjelica, & Masanovic, 2019). Large body mass is less important to wings because they usually operate in clear situations, that is, they rarely have contact with the opposite defensive players.

In contrast to other positions, the characteristics of the goalkeepers were statistically significantly larger in all studied parameters. This finding is parallel with previous study that showed goalkeepers were characterized by dominant pronounced longitudinal dimensionality, bone composition and voluminosity. This is largely due to their limiter playing area. Most of their skills focused on fast and explosive movements, performed to save a shot or throwing to their team mates when the ball is out of play from the back line. These movements are deemed to be not so demanding in energy expenditure (Póvoas etal., 2014). The criteria for a goalkeeper's physique are they should be of substantial height and

with substantial upper and lower extremities needed to cover between the goalposts (Srhoj et al., 2002).

4. CONCLUSION

Present findings provide a clearer insight into the morphological and anthropometric characteristics among Malaysian youth handball players according to playing position as well as gender. To identify playing position, male and female players may be different in body weight, height, body mass index, and arm span by excluding leg length parameters. It concluded that the coach may exclude certain parameters in anthropometric measurements when identifying appropriate player positions through morphological profile category. The morphology and anthropometric measures of a handball players can be added value for coaches to consider when assigning the individual to specific playing positions and designing more effective training programme that suits the players' physical properties. This novel information would assist in not only suitable players according to positions but enhance the tactical skills training of the team as the players would be able to perform set pieced more effectively. At the same time, the period of fitness can be reduced and save manpower.

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