
ANTHROPOMETRIC, PHYSICAL FITNESS AND MENTAL TOUGHNESS OF CANOE POLO ATHLETES

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ABSTRACT

This study aimed to compare the anthropometric characteristics, physical fitness, and mental toughness components between elite and junior team canoe polo in Malaysia. Participants were 20 elite paddlers and 20 junior paddlers of Johor and Wilayah Persekutuan state (n=40; male: 20 and female: 20). Participants underwent an anthropometric measurement (height, body mass, body mass index, body fat, skeletal muscles mass, visceral fat, and arm span), physical fitness test (push up, sit up, back extension, plank and 1.6km) and Psychology Performance Inventory (PPI) administration. The findings showed that there are significant differences between elite and junior in body mass ($t=2.582$, 0.015 , $p<0.05$), skeletal muscles ($t=4.780$, 0.030 , $p<0.05$), visceral fat ($t=2.318$, 0.026 , $p<0.05$) and arm span ($t=2.693$, 0.011 , $p<0.05$). There are also significant differences in all physical fitness components between elite and junior team including push up ($t=3.874$, 0.000 , $p<0.05$), sit up ($t=2.787$, 0.008 , $p<0.05$), back extension ($t=2.279$, 0.029 , $p<0.05$), plank ($t=4.679$, 0.000 , $p<0.05$) and 1.6km run test ($t=-3.085$, 0.004 , $p<0.05$). There are significant differences on negative energy between men and women elite and junior canoe polo players ($t=2.45$, 0.02 , $p<0.05$), visual and imagery ($t=-1.25$, 0.01 , $p<0.05$) toughness between men and women elite and junior canoe polo players and the positive energy ($t=-4.25$, 0.00 , $p<0.05$) and attitude control ($t=-2.84$, 0.01 , $p<0.05$) between national and state elite and junior canoe polo players. In conclusion, the results showed that paddlers with longer arm spans have more canoe polo advantages. In terms of fitness level, muscular strength, muscular endurance, and aerobic capacity are essential components to excel in this sport. Meanwhile, the level of mental strength is important for performance development of each athlete and varies according to individual psychological health. These findings help coaches conduct talent identification programs and plan training programs for athletes.

Keywords: *Canoe polo, Anthropometric, Physical Fitness, mental toughness*

INTRODUCTION

Canoe polo is one of the competitive disciplines of kayaking sport that combines paddling and throwing the ball. Two teams, including five players each, play this sport on a rectangular pitch such as open water or swimming pool. The kayak used in canoe polo is different from other kayaking sports, which is lighter and more difficult to control. The ball in canoe polo is the same used in water

polo and controlled by hand or paddle. The period for the matches is 10 minutes over two halves and in that time the players need to score a goal to be considered as the winner for that match. Canoe polo is a contact team game in which tactics and positional play are important along with the strength, speed, and fitness of the individual athletes.

Canoe sport in Malaysia evolved through education in 1952 at Lumut, Perak. After 30 years, canoe polo was introduced in the 1980s at Pulau Pinang, Malaysia. The first international canoe polo competition in which Malaysia competed was in 1985, which was First Asian Canoe Polo Championship in Kobe, Japan and got third place in that competition. Until 1996, Malaysia Canoe Association (MASCA) invited a coach from Indonesia to train future canoe polo coaches. Since then, canoe polo sport has become popular among canoe sport enthusiast in Malaysia and has competed in many international competitions such as the world championship, Asian games and several national players were invited to play with other clubs in the canoe polo league in China. The highest achievement is achieved by ranking 9th in the world championship, 2nd place in Asian Games and 2nd place for those under 21 years old in Asian Canoe Polo Championship.

When talking about success, many factors influence an athlete's success in any level such as state, national or international. Even though lot of achievements have been achieved, each player's performance must be developed and maintained to improve their gameplay and develop new athletes. As we know, canoe polo sport involves upper body movement and less involving in lower body movement. This is because it is combined with paddling canoe and throwing the ball. Most athletes must have suitable physical characteristics, endurance, or upper body strength due to specific sports skills such as passing, rolling, controlling, and shooting. The athlete needs a good and suitable physiological characteristic to have good passing, rolling, controlling and other skills. Physiological characteristics will help identify a difference of characteristic and fitness level among athletes and assist the coaches in preparing suitable training for their athletes. Physiological characteristics can be measured by anthropometry measurements, aerobic fitness, or others.

In this study, the process of identifying the physiological characteristics of canoe polo players is by measuring their anthropometry and physical fitness components. According to Centers for Disease Control and Prevention, anthropometry is the study of the measurement of the human body in terms of the dimensions of bone, muscle, and fat. Based on previous research, anthropometry plays an important role in building the body with various measurements of the body segment which is suitable with game and sport also essentially helpful to success in the game especially in canoeing and kayaking game (Shashikant, 2018). Anthropometry measures may help to identify an athlete with better physical and physiological needs according to that sport's needs. Besides that, previous research also showed that anthropometry measures can help to compare physiological characteristics between the athletes to identify the suitable playing position in matches (Sheykhlovand et al., 2015). This is because in canoe polo, players such as attackers, defenders, and goalkeepers exist. Each playing position has different anthropometry components such as position goalkeeper that suits an athlete with a higher body height (Sheykhlovand., 2015). Other than anthropometry measurement, aerobic fitness also can measure the physiological characteristics of an athlete.

Besides anthropometry measurement, physical fitness component is a factor in identifying physiological characteristics or determineng an athlete's fitness level. Physical fitness refers to the ability of the body's systems to collaborate efficiently to maintain health and perform daily living activities. It is an essential factor in sports performance, especially in any sport involving an interval of aerobics, endurance and strength. As we know, canoe polo is a high-intensity intermittent sport requiring periods of high effort followed by periods of lower intensity (Sheykhlovand & Scott, 2018). It is also mainly covered by the aerobic energy system because the recovery between high-intensity also reliant on aerobic metabolism (Mohsen & Scott, 2018). This very emphasis is on the athlete's endurance, aerobic fitness, and strength to ensure the athlete can survive throughout the match. By measuring physical fitness, it can help to identify the endurance, aerobic capacity, and strength of the athlete.

In addition, sports psychology is a field that involves observing behavior and seeing the impact that can have an impact on sports performance. Achievement in sports not only results from strength or physiological fitness and biomechanical factors which are purely technical but involve factors of psychology too. Research studies involving peak performance and successful athletes show that the athlete's psychological profile such as high self-confidence high, energy, self-control,

concentration, positive attitude, seriousness, and commitment helps athletes' success of athletes (Krane & Williams, 2006). Athletes with skills in sports psychology are expected to have self-control and good stress control. The psychological impact of sports is very important to build awareness of the athlete's mind, form high discipline, control stress well as well as increase the self-confidence of athletes whether outside or in the venue. Athletes with skills in psychology sports can increase self-confidence and build team harmony well.

MATERIALS AND METHODS

Participants

The population and sampling for this study were all elite teams and junior team of canoe polo. The total average for the sampling is about 60 athletes, 30 elite athletes and 30 junior athletes. In this study, the sample is categorized into two teams which is elite team is the athletes who competed at the national and international level, while the junior team is the athletes who competed at the state level.

Procedures

The study started with the distribution of profile forms, a briefing, and the signing of consent forms at canoe polo team training center, Kompleks Sukan Kanu Negeri Johor and Kuala Lumpur Canoe Club training center, Tasik Titiwangsa, Kuala Lumpur. The test was measured during their rest day including anthropometric measurement (body mass, body mass index, body fat, skeletal muscle, visceral fat, and arm span) using the TANITA BC-545N, Japan. Then followed by core strength test (push up, sit up and back extension test in 1 minute), aerobic fitness test (1.6km run test) and mental toughness (Psychology Performance Inventory (PPI) (Loehr, 1986).

Statistical Analysis

Variables were described by their mean (M) and standard deviation (SD). The Kolmogorov–Smirnov test and Shapiro–Wilks test was used to check the normality of the data. The independent t-test was used to determine the differences between sport levels. The analysis of data was performed using the software package by using $\alpha = 0.05$ confidence level (Ozdamar, 1999) by Statistical Package for Social Sciences (SPSS) version 22.0. Before the main analysis, the data were screened for accuracy, missing values, outliers, and basic assumptions. The reliability of the psychological questionnaires was calculated using Cronbach's alpha.

RESULTS

In this study, most of the athlete's age between 20 to 30 years old is 65%, age between 13 to 19 years old is 32.5% and only 2.5% of athlete's age is over than 30 years old. Most of the athlete's weight between 50 to 70kg with 57.5% while weight between 42.70 to 49kg with 22.5%. Only 20% of athletes which is 8 athletes have weight more than 70kg. Meanwhile, the athlete's height between 149cm to 159cm is 40%, between 160cm to 169cm is 32.5% and only 27.5% of athlete's height is more than 170cm. There are two levels of participation which is elite with 20 athletes (50%) and junior level with 20 athletes (50%) – refer to Table 1.

Table 1. Descriptive analysis of athlete background (age, gender, weight, height, and level of participation)

Variable	N (%)	M	SD	Maximum	Minimum
Age					
< 20	15(32.5)				
20-30	26(65)				
>30	1(2.5)	20.8	4.4	33	13
Gender					
Male	20(50)				
Female	20(50)	1.5	0.5		
Weight					
<50kg	9(22.5)				
50-70kg	23(57.5)				
>70kg	8(20)	60.1	13.4	97.85	42.70
Height					
<160cm	16(40)				
160-170cm	13(32.5)				
>170cm	10(27.5)	163.4	10.1	185	149
Level of participant					
Elite	20(50)				
Junior	20(50)	1.5	0.5		

Regarding to anthropometric variables, there are significant differences between elite and junior in body mass ($t=2.582$, 0.015 , $p<0.05$), skeletal muscles ($t=4.780$, 0.030 , $p<0.05$), visceral fat ($t=2.318$, 0.026 , $p<0.05$) and arm span ($t=2.693$, 0.011 , $p<0.05$). The difference showed that elite team have higher score than junior team in body mass, skeletal muscles, visceral fat and arm span. There are no significant differences in height ($t=1.922$, 0.062 , $p>0.05$), body mass index ($t=1.869$, 0.071 , $p>0.05$) and bodyfat ($t=1.252$, 0.217 , $p>0.05$). Refer to Table 2.

Table 2. Descriptive and anthropometric characteristics difference of elite and junior canoe polo team

Variable	Elite		Junior		Level of Significance	
	M	SD	M	SD	t	p
Height (cm)	166.40	10.78	160.45	8.68	1.922	0.062
Body mass (kg)	65.25	15.81	54.97	8.14	2.582	0.015*
BMI (kg/m)	23.14	3.92	21.24	2.29	1.869	0.071
Bodyfat (%)	20.08	6.87	17.31	7.08	1.255	0.217
Skeletal muscles (kg)	48.92	9.26	43.19	6.46	2.269	0.030*
Arm span (cm)	170.75	11.34	162.15	8.67	2.318	0.026*
Visceral fat	6.05	3.89	3.55	2.83	2.693	0.011*

Note: * $p \leq .05$

SD Standard Deviation

Figure 1 showed a comparison of anthropometric characteristics between elite and junior team. Regarding to physical fitness variables in Table 3, there are significant differences in all physical fitness components between elite and junior team such as push up ($t=3.874, 0.000, p<0.05$), sit up ($t=2.787, 0.008, p<0.05$), back extension ($t=2.279, 0.029, p<0.05$), plank ($t=4.679, 0.000, p<0.05$) and 1.6km run test ($t=-3.085, 0.004, p<0.05$). This finding also showed that the elite team have higher score than the junior team except for the 1.6km run test.

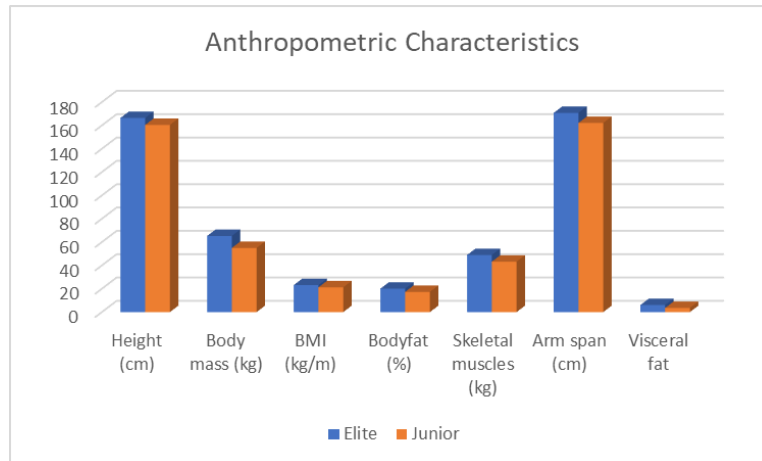


Figure 1. A comparison of anthropometric characteristics between elite and junior team

Table 3. Descriptive and physical fitness difference of elite and junior canoe polo team

Variable	Elite		Junior		Level of Significance	
	M	SD	M	SD	t	p
Push up (reps)	66.35	13.80	47.45	16.89	3.874	0.000*
Sit up (reps)	60.90	15.84	47.20	15.24	2.787	0.008*
Back extension (reps)	63.15	12.57	55.45	8.38	2.279	0.029*
Plank (min)	5.03	1.57	2.69	1.58	4.679	0.000*
1.6km run test (min)	8.13	1.57	10.45	2.95	3.085	0.004*

Note: * $p \leq 0.05$, SD = Standard Deviation

Figure 2 showed a comparison of physical fitness components between elite and junior team. Regarding to the level of mental toughness between men and women elite and junior canoe polo players (refer to Table 4.4), there is a significant difference in negative energy variable between men and women elite and junior canoe polo players ($t=2.45, 0.02, p<0.05$). This finding showed that men have higher negative energy than women elite and junior canoe polo players.

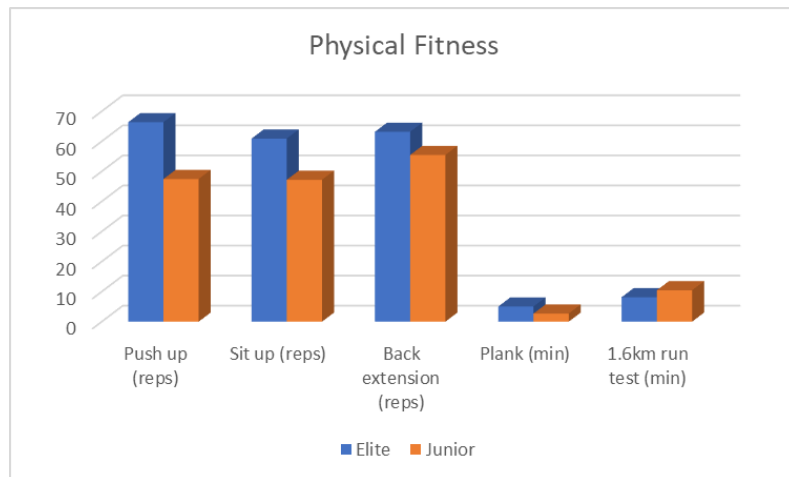


Figure 2. A comparison of physical fitness components between elite and junior team.

Table 4. Descriptive Analysis and t-test the level of mental toughness between men and women elite and junior canoe polo players

Variable	Men		Women		t	P
	M	SD	M	SD		
Self-confidence	14.70	1.92	14.40	2.89	0.45	0.66
Negative energy	20.15	1.95	18.05	3.30	2.45	0.02*
Attention control	20.60	2.78	19.50	3.00	1.20	0.24
Visual and imagery	11.20	2.50	13.25	4.18	-1.81	0.80
Motivation level	12.95	1.57	14.10	2.43	-1.78	0.85
Positive energy	12.10	2.63	12.40	3.12	-0.33	0.74
Attitude control	13.50	2.50	13.25	2.67	0.33	0.74

Note: * $p \leq 0.05$, SD = Standard Deviation

Regarding the level of mental toughness between national and state elite and junior canoe polo players (Table 5), there is a significant difference in visual and imagery variable ($t=-2.84$, 0.01, $p<0.05$), positive energy ($t=-4.25$, 0.00, $p<0.05$) and attitude control ($t=-2.84$, 0.01, $p<0.05$) between national and state elite and junior canoe polo players. This finding showed that state have higher visual and imagery, positive energy, and attitude control than men national and state elite and junior canoe polo players.

Table 5. Descriptive Analysis and t-test the level of mental toughness between national and state elite and junior canoe polo players

Variable	National		State		t	P
	M	SD	M	SD		
Self-confidence	14.05	2.67	15.00	2.13	-1.25	0.22
Negative energy	19.60	3.19	18.60	2.60	1.10	0.28
Attention control	20.65	3.09	19.45	2.72	1.32	0.20
Visual and imagery	10.70	3.18	13.75	3.60	-2.84	0.01*
Motivation level	13.15	2.11	13.90	2.07	-1.13	0.26
Positive energy	10.65	2.58	13.85	2.16	-4.25	0.00*
Attitude control	12.40	2.16	14.35	2.18	-2.84	0.01*

Note: * $p \leq 0.05$, SD = Standard Deviation

DISCUSSION

Anthropometrics were used to identify individual physical characteristics. In addition, this anthropometric is used when a coach wants to identify their athletes who have the desired characteristics or meet the needs of the sport. In various types of sports, anthropometric measurements have some effect on the performance of athletes in those sports. Based on previous research, anthropometric plays a major role in building the body with various measurements of the body segment which is suitable with games and sport also essentially in giving the advantageous to success in the competition, particularly for canoeing and kayaking (Shashikant, 2018). Besides, anthropometrics in canoe sports needs to be emphasized because it involves the use of many muscles, appropriate body size, body weight and so on. Therefore, this anthropometric measurement can help coaches provide appropriate training programs according to the measurements' results. For example, if some athletes less muscles, the training program should include more hypertrophy training. Anthropometric measurement also may help to identify the physical and physiological strengths and weaknesses according to the needs of canoe sport for both groups of athletes.

This study finding reveals significant differences between body mass, skeletal muscles, visceral fat percentage and arm span between elite and junior canoe teams. This finding showed that elite athletes have a higher percentage for those variables. This finding was supported by the previous study stating that young kayakers and canoeists have a lower body mass (Gabler et al., 2021). The body mass of the elite team is higher than junior team. Meanwhile, a previous study conducted among Iran National Polo team is found that, body mass among the elite team is lower than junior Canoe (Sheykhloovand et al., 2015). Sheykhloovand et al. also suggest that the elite team's fat percentage is probably due to a lack of endurance activities in their training (2015).

The skeletal muscles of a kayak play a crucial role in the propulsion and manoeuvrability of the vessel (Ghazali et al., 2021). These muscles, including the muscles of the arms, shoulders, and core, generate the power and force necessary to paddle and steer the kayak effectively. Without strong and well-conditioned skeletal muscles, the kayaker may struggle to maintain proper technique, control, and overall performance on the water. The proper maintenance and strengthening of these skeletal muscles through targeted exercises and training regimens is essential for kayakers to maximize their potential and minimize the risk of injury and fatigue.

A study conducted by Sheykhloovand Gharaat, Bishop, Khalili, Karami & Fereshtian (2015), to determine the physiological, anthropometric and performance characteristics of elite canoe

polo players. The participants underwent body composition assessment using bioelectrical impedance analysis, Wingate-30s, aerobic power, flexibility, muscular strength, endurance, and maximum speed test. The result of this study, the researchers hypothesized that high anaerobic power and dynamic strength would be required for canoe polo performance and throwing velocity would be one of the most significant technical requirements for success in canoe polo competition. The findings also found that their canoe polo player had a high percentage of body fat, probably due to a lack of endurance activities in their training.

A study conducted by Tamoghni and Adhikari (2018) aimed to determine and compare various physical and anthropometrical parameters among Indian male junior rowers, kayakers, and canoers. The findings of this study were that the height of kayakers is higher than canoeists, the rower's arm span is higher than kayakers and the ectomorphic element, forearm length and trunk flexibility are higher than canoers. According to Tamoghni and Adhikari (2018), the significant differences are because rowing creates more resistance than paddling.

The results of this study also displayed the significant difference between all physical fitness components between elite and junior canoe teams. The elite team showed a better physical fitness level compared to junior canoe team except for the 1.6km run rest. These finding parallels previous studies, in which elite canoe polo athletes showed higher 1RM bench press and agrees that muscle strength can be an essential component to success in canoe polo (Sheykhlovand et al., 2015). In sport, the purpose of physical fitness is working out all muscles to strengthen the muscles (Kirandi, 2016). Canoe polo is a competitive sport that combines many specific sports skills. Canoe polo is a competitive ball sport discipline in canoe sport which combines the skill of paddling and ball playing simultaneously. The skill of paddling and ball playing involves a repetitive movement of paddling and rolling, speed, power, and strength. Moreover, it entails breaking away during counterattacks, accelerating to gain possession of the ball, and using individual play between athletes in various positions to displace one another and gain control of the position (Christiano et al., 2012). These movements need higher muscle endurance, strength, speed, power, and others. According to Christiano et al. (2012), muscle strength correlated with muscle power may be an essential component for success in canoe polo than other competitors in endurance type events. This shows that in canoe polo need higher muscles strength and muscles power. Besides that, canoe polo sport consists of two periods of 10 minutes play with three minutes rest between the periods. This sport involves a high-intensity intermittent that requires periods of high effort followed by periods of lower intensity (Sheykhlovand, Khalili, Agha-Alinejad & Gharaat, 2016). This shows that canoe polo players need high aerobic and anaerobic capacity to perform better.

Moreover, the size and height of canoe polo players also influences the gameplay. The size and height of the athletes can affect the gameplay where their game involves attacking and defending. A mesomorph-like body helps to break the defensive formations made by the opponent. The body's height also gives the athlete an advantage to intercept and prevent the opponent from attacking or scoring a goal. In addition, in canoe polo there are positions such as attacker, defender and goalkeeper. The players with higher body height are suitable to play in goalkeeper position (Sheykhlovand & Scott, 2018). Therefore, the physiological and physical demand were influenced in the canoe polo sport. This physiological and physical demand of athletes in sports can be identified by doing physical tests such as fitness tests.

Furthermore, this study showed a significant between mental toughness between men and women elite and junior canoe polo players. This showed that men athletes are more likely to have negative energy than women during training or competition compared to the other factors. However, the finding also reveals a significant difference in the level of mental toughness between national and state elite and junior canoe polo players. The results showed that state players have more practices on visual and imagery, positive energy, and attitude control than national players in terms of mental toughness. Every coach and athlete need to aim for the goals they want to achieve in the field of sports they are engaged in. In achieving the set goals, athletes need motivation to help themselves face the competition. Based on Raedeke's study (1997) states that individuals who participate longer have high motivation. But his view is different from the opinion presented by Hodge et al., (2005) who stated that the achievement of goals depends on the attitude of the athlete when he is at something that is at a high level as well as a low level. Based on the statement, the athlete's motivation depends on their own attitude when in something competition or training and how they motivate themselves.

Therefore, attitude control is a factor that also affects mental strength and good attitude control can influence the athlete's behavior to always be calm and positive when facing any pressure and challenge during training or competition.

In addition, according to Goldberg (2013) the level of mental strength for an athlete's challenge criteria is dependent on mental skills to recover from some stress and mistakes. The wisdom of an athlete is determined through the ability to overcome live challenges during action. An athlete's ability to overcome challenges and pressure in competition can be linked to attitude control. Therefore, mental strength is the main factor in determining success in sports (Sheard & Golby, 2006). Athletes with good mental strength good is more likely to be successful and competitive.

CONCLUSIONS

Based on the study, the anthropometry characteristics and physical fitness between elite and junior canoe polo team in Malaysia demonstrated that the elite canoe polo team have higher skeletal muscles, arm span and higher in physical fitness compared to the junior canoe polo team. However, the junior team has more visceral fat and body mass percentage. Junior athletes with a target to compete at the international level also need to be concerned about the anthropometry characteristics, physical fitness components and mental toughness factor. The result of this study may help coaches identify the capability of athletes and improve their athletes according to the needs and demands of this sport.

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