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Comparison of Body Composition and Handgrip Strength of National Defence University of Malaysia (NDUM) Precision Athletes

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ABSTRACT

Precision athletes require good upper limbs strength to perform well on their respective sports regardless of their body shape but most of them neglect the importance of having a good handgrip strength. The objective of this study was to investigate the differences between anthropometric measurement, body composition and handgrip strength among National Defence University of Malaysia (NDUM) precision athletes. The NDUM's precision athletes were divided into three types of precision sports which were archery, shooting and lawn bowl. Forty-two active NDUM's precision athletes aged 19.6 ± 1.06 years (archery); 20.5 ± 1.43 years (shooting); 20.0 ± 1.62 (lawn bowl) were participated in this study. All the athletes were evaluated for anthropometric parameters (height, weight, BMI) using standard procedures. Body composition (body fat percentage (%), muscle mass (kg), bone mass (kg), total body water (%), visceral fat level (%) was assessed using bioelectrical impedance analyser (BIA) while for handgrip strength test were using handgrip dynamometer (KYTO, EH101, KYTO Fitness Technology, China) with standard procedures. The results indicated that there was no significant difference between NDUM's precision athlete in term anthropometric parameters, body composition and handgrip strength. However, visceral fat showed a significant different ($p \leq 0.05$) between archers and shooters. In conclusion, this study may conclude that all the NDUM's precision athlete have a similar anthropometric characteristic, body fat percentage (%), muscle mass (kg), bone mass (kg), total body water (%) and handgrip strength except the visceral fat level.

Keywords: *Precision Athlete, Anthropometry, Body Composition, Handgrip Strength*

INTRODUCTION

Precision sport is a sport that requires athlete to be accurate and precise on target to gain more points during the match. Archery is a precision sports as the main objective to aim and shoot at the target board (Decheline et al., 2020). Spratford & Campbell, (2017) stated that archers use bows and arrows to shoot arrows at targets that are set in place the goal is to acquire precise target shooting results by deliberate and methodical training. Archery also requires upper body strength particularly within the shoulder muscles (Spratford & Campbell, 2017).

Spancken et al. (2021) on the other hand stated that shooting is an accurate and precise sport that everyone, regardless of age, sex, or ability level, may participate in. It also requires athlete to take aim and shot at the target face. The sports shooting in the Olympic Games have more than fifteen different categories and standing air rifle and air pistol shooting are the most technical categories since it requires shooter to have a high level of precision (Ihalainen et al., 2018). According to Mullineaux et al. (2012), it is crucial for shooters to have a good quality of controlled grip of the weapon and hand working together to have an accurate shooting during the events. Handgrip also had been known as one of the components than complement the shooting skills of the shooter. Nevertheless, accurate trigger control rather than accurate sight control is what produces good, powerful hits. Pulling the trigger will cause the shooters to miss the target even if their sights are in alignment and their sight image is flawless.

In the target sport of lawn bowls, players alternately roll their bowls as closely as they can to a small target bowl (referred to as the Jack) that is placed between 23 and 37 metres away (Sayers, 2019). To differentiate lawn bowl from other precision sports that had been mentioned, it requires the curved trajectory of the bowl itself (Birse et al., 2022). The athlete can control the trajectory's curvature as they draw the ball in addition to the asymmetrical spherical design and axis of rotation.

For athletes participating in precision sports like archery, shooting, and lawn bowling, handgrip strength is crucial. But not all precision athletes have powerful grips. This will make it tough for them to pull triggers on devices like pistols and archery bows (Ganjave & Dabholkar, 2022). Precision athletes frequently engage in upper body exercises. The forearm, shoulder, and wrist, which are three of the most crucial body components for precision athletes especially on archery events (Prasetyo et al., 2023). Stabilizing something requires the use of the forearm and shoulder. Before the shot is fired, it will be especially helpful for archers in the firing position or archers in the archery position. In addition, precision athletes do not view the importance of handgrip strength in their respective sports.

METHODOLOGY

Subject

The present cross-sectional study was carried out on 42 NDUM's athlete includes 8 archers (19.6 ± 1.06 years old), 20 shooters (20.5 ± 1.43 years old) and 14 lawn bowlers (20.0 ± 1.62 years old). A complete explanation of the procedures, potential risks and benefits of the tests were explained to all the subjects, and signed consent was obtained prior to the testing.

Anthropometric Measurement

Anthropometric measurement was taken included height (cm), resting heart rate, and waist to hip ratio. Waist to hip ratio were measured manually with a measuring tape by the researcher. Body weight (kg). Body Mass Index (BMI), Basal Metabolic Rate (BMR), body fat percentage, muscle mass, and visceral fat were measured through Bioelectrical Impedance Analysis (BIA) (BC-601F FitScan. Tanita. USA).

Body Composition

Body composition, including body fat percentage (%), muscle mass (kg), bone mass (kg), total body water (%) and visceral fat level (%) were measured using Bioelectrical Impedance Analysis (BIA) with the standard procedure.

Figure 1: Body Composition Measurement

Hand Grip Strength Measurement

Handgrip strength (kg) was measured with the help of a handgrip dynamometer (KYTO, EH101, KYTO Fitness Technology, China) using standard procedures. Handgrip strength quantification can be done more effectively, objectively, sensitively, and affordably with handheld dynamometry (HHD). During a maximal isometric contraction, the examiner presses a small, portable object against the patient's limb. All of the extremities' proximal and distal muscles can be tested with the apparatus. To measure grip strength, certain 17 dynamometers are utilised. Standardized testing positions help to lower serial measure variance. This strength measurement corresponds well with fixed dynamometry up to 30-kg force and is more change-sensitive than manual muscle testing (MMT).

Hand Grip Protocol

Figure 2: Vertical Standing Position

Archery

Archers were performed a handgrip strength test twice. For the first test, the archers were standing in a vertical position. After that, the archer held the handgrip of the dynamometer with a straight hand and the test was started. The second test, the archer stood in a position with one foot on each side of the shooting line about shoulder width apart. Equal weight on each leg. The draw toe was moved about 4 inches in front of the bow toe. Pivot on the toes and point the toes about 30° toward the target. Handgrip dynamometer was in the hand that does the pulling

Figure 3: Archery Position

Shooting

Shooting athletes was performed a handgrip strength test twice. For the first test, the shooter was standing in a vertical position. After that, the shooter held the handgrip of the dynamometer with a straight hand and the test was started. The second test, 19 shooter stood in a position the feet are about a shoulder-width apart. Their back leans slightly away from the direction of shooting and held non-shooting (left) hand, their arm at side in a fixed but relaxed position by hooking the thumb in their pocket. Then, the arm was stretched, the wrist was kept motionless, and the elbow was straight and to the test.

Figure 4: Shooting Position

Lawn Bowl

Lawn bowler athletes were performed a handgrip strength test twice. For the first test, the lawn bowler was standing in a vertical position. After that, the lawn bowler held the handgrip of the dynamometer with a straight hand and the test was started. The second test, lawn bowler stood in a position to draw a bowl.

The body was in a slightly bent position while the non-dominant leg was one step in front. The test was started while hand is in the position for make a shot.

Statistical Analysis

The analysis of this study was accomplished by using Statistical Package for the Social Science (SPSS) program version 20. The subject's data anthropometric (age, height, weights, BMI and BMR), body composition (body fat, muscle mass, bone mass, total body water and visceral fat) and handgrip strength dominant and non-dominant were completed through one-way analysis of variance (ANOVA). The significance level was chosen at $p < 0.05$.

RESULT AND DISCUSSION

Anthropometric

Table 1 presents a comparison of anthropometric parameters between NDUM's precision athletes (lawn bowlers, shooters, and archers). No significant differences were identified for the following variables: age, height, weight, BMI and Basal Metabolic Rate (BMR) between groups. However post-hoc test revealed that there are significant differences on body weight, BMI, and BMR between archery and lawn bowl.

Table 1: A comparison of anthropometric parameters between NDUM's precision athletes

Parameter	Lawn bowl (*n* = 14)	Shooters (*n* = 20)	Archery (*n* = 8)	Level of significance (2 tailed)
Age (yrs)	20.0 ± 1.62	20.5 ± 1.43	19.6 ± 1.06	0.313
Height (cm)	163.93 ± 7.22	164.0 ± 7.62	164.88 ± 9.43	0.960
Weight (kg)	59.29 ± 7.40	65.7 ± 15.11	73.88 ± 23.09	0.101
BMI	22.0 ± 2.08	24.3 ± 4.37	26.8 ± 6.52	0.051
BMR	2828.4 ± 411.59	3039.5 ± 725.42	3523.0 ± 947.93	0.086

Shooting, archery and lawn bowl are similar in nature, but the player's physiological profiles are different as the skill-related physical fitness components are meant to be different between the three sports. These sports have specifics demands for the body height, weight, BMI, BMR body fat, muscle mass, bone mass, total body water and visceral fat level, which are the most important prerequisites to succeed in the competition.

The main findings of the present study demonstrated that there were no significant differences on anthropometric measurements (age, height, weight, BMI and BMR), body composition analysis (body fat, muscle mass, bone mass, total body water and visceral fat level) and handgrip strength among precision athletes. However, this present study provided a clear difference in visceral fat level because there was significant difference on visceral fat between archery and lawn bowl.

Even though there are no significant differences were identified for the following variables: age, height, weight, BMI, and BMR between groups, post-hoc test revealed that there are significant differences on body weight, BMI, and BMR between archery and lawn bowl.

The World Health Organization (WHO) defines underweight as having a body mass index (BMI) of less than 18.5 kg/m², normal weight as having a BMI of less than 25, overweight as having a BMI of more than 25, and obesity as having a BMI of more than 30 kg/m² (WHO, 2020). Although BMI is often used, it is only calculated using a small amount of data (height and weight) and does not take into account body composition. As a result, BMI has a low sensitivity to detect illness risk in subpopulations like older adults, women, people of different racial and ethnic backgrounds, and athletes (Walsh et al., 2018). Physical stature is not given much weight in archery, but physical strength and general fitness are valued more by top-level competitors. The placement of the archer's arrows on the target is based on psychological, physical, and environmental elements that should be evaluated (Eswaramoorthi et al., 2018).

BMR is the minimal amount of energy needed to keep the body's physiological processes going while awake. In most healthy persons, BMR makes up between 45% and 70% of total energy expenditure. Gender, age, body surface area, body composition, genetic makeup, and other factors have a direct impact on BMR. On previous study, a high level of static equilibrium is needed for the sport of archery. An archer needs to be able to maintain more stability in their posture to score higher. Therefore, they must have an endomorphic body type, which is characterised by a pear-shaped figure, body fat, and lower upper arms, thighs, and legs (Taha et al., 2016)

Body Composition

Table 2 reveals a comparison of body composition between NDUM's precision athlete. No significant differences were identified for the following composition parameters: body fat (%), muscle mass (kg), bone mass (kg) and total body water (%). However, it has been proven that there were significance differences in the visceral fat level between archery and lawn bowl.

Table 2: A comparison of body composition between NDUM's precision athletes

Parameter	Lawn Bowl (*n* = 14)	Shooters (*n* = 20)	Archery (*n* = 8)	Level Of Significance (2 Tailed)
Body Fat (%)	20.6 ± 8.41	21.9 ± 8.62	21.73 ± 7.49	0.905
Muscle Mass (kg)	44.39 ± 9.21	48.4 ± 11.94	54.1 ± 15.44	0.181
Bone Mass (kg)	2.6 ± 0.35	2.8 ± 0.53	3.1 ± 0.74	0.135
Total Body Water (%)	50.0 ± 5.50	50.0 ± 6.19	47.8 ± 5.32	0.625
Visceral Fat Level	3.1 ± 1.54	5.3 ± 4.05	7.6 ± 5.18	0.026

Table 2 shows body composition data where one of the data involves body fat. However, this present study could not detect any significant differences on fat percentage of NDUM's precision athletes. The fat percentage of NDUM's precision athletes under 30% which is consider good for health and performance. Body fat has many benefits for athletes. Additionally, body fat has a mechanical and metabolic impact on physical performance (Esco et al., 2018). Lower fat is thought to be a performance indicator for shooting, with higher performance being predicted by lower fat (Manna et al., 2017). Other than that, it benefits more than simply how your body feels to lose body fat. Along with reducing various physical threats, it improves mental and emotional wellbeing.

The results of visceral fat level present that there was a significant between NDUM's precision athlete. Visceral fat is a particular kind of fat that surrounds the organs in the abdominal cavity of the body and known as abdominal fat or central fat (Lee et al., 2021). Archery athletes showed the highest value with a mean value (7.6 ± 5.18) compared to shooting (5.3 ± 4.05) and lawn bowling (3.1 ± 1.54). This is not good for archers because visceral fat, which also known as 'hidden' fat, is fat stored deep inside the belly, wrapped around the organs, including the liver and intestines, has a less detrimental effect on general health and is generally simpler to lose. Lee et al. (2021) stated that high levels of plasma glucose and triglycerides, insulin resistance, high blood pressure, and systemic inflammation are health issues that are particularly related with high visceral.

Hip circumference varies significantly more widely due to variations in pelvic bone form, quantity of subcutaneous adipose tissue, and muscle mass. In addition, archery requires a greater body mass in the sport because of the high static balance required for the sport of archery. Most of the archery have an endomorph body. The endomorph body type is characterised by a pear-shaped figure, body fat, and lower upper arms, thighs, and legs, a high static stability. Nasrulloh et al. (2022) suggests that an archer should be able to maintain more stability in their posture to score higher in the tournament.

Hand Grip Strength

Table 3 depicts comparison of handgrip strength parameters between precision athletes. No significant differences were identified for the following dominant and non-dominant hand between precision athletes. However, Table 4 shows that there were significant differences between male and female precision sports athletes.

Table 3: A comparison of handgrip strength between NDUM's precision athletes

Parameter	**Lawn bowl (*n* = 14)**	**Shooters (*n* = 20)**	**Archery (*n* = 8)**	**Level of significance (2 tailed)**
Dominant	35.8 ± 10.90	36.26 ± 9.44	37.9 ± 10.81	0.890
Non-Dominant	30.2 ± 9.35	34.0 ± 8.87	34.8 ± 9.49	0.406

Handgrip, the important of handgrip in precision athletes. However, this present study could not detect any significant differences among precision athletes. Based on Table 3, dominant handgrip strength for archery (37.9 ± 10.81), shooters (36.26 ± 9.44) and lawn bowl (35.8 ± 10.90). It may have concluded that all the NDUM precision athletes have similar hand grip strength for both dominant and non-dominant hand.

The results of handgrip strength could be considered as normal if refer to Table 3. As an athlete, by getting a normal score has proven that a person has a strong grip. Handgrip strength is a useful indicator of potential decline in physical mobility, cognitive status, health-related quality of life, general physical function, and mortality risk (Jordre & Schweinle, 2020). Bardo et al. (2021) suggested that it is also as tool to measure the form of human while performing their various activity especially on upper body. The same researcher suggests that various factors were included in determining the level of hand strength such as hand dominance asymmetry.

Although no significant differences in the total body water were found, water was important because the proportion of water in the human body should be at least 50%. To counteract their higher sweat losses and maintain hydration balance, athletes need to consume enough water (Matias et al., 2019). Fauza & Astuti, (2022) stated that hydration level is very important to maintain the body balance among athletes. Loss of water while performing sporting activities can impair the athlete performance hence it is important to maintain the good level of hydration throughout the competition especially for those precision athletes that compere in outdoor environments (Fauza & Astuti, 2022).

Hence, the absence of significant difference among NDUM's precision athlete on anthropometric measurement, body composition and handgrip strength may conclude that NDUM's precision athlete have similar characteristics in term of height, percentage of body fat, muscle mass, bone mass and level of body water. However, visceral fat or archers were significantly high compared to lawn bowl. In addition, this study also may conclude that all the NDUM's precision athlete have a similar strength or handgrip level despite of their specific nature of each sport.

CONCLUSION

In summary, based on the results of the present study, the lack of significant difference among NDUM's precision athlete on anthropometric measurement, body composition and handgrip strength may justify that NDUM's precision athlete have similar characteristics in term of height, percentage of body fat, muscle mass, bone mass and level of body water.

However, the only area showed a significant change between NDUM's precision athletes was the visceral fat only. Furthermore, this study also may demonstrate that all the NDUM's precision athlete have a similar isometric strength of the hand and forearm muscles despite of their specific nature of each precision sports.

Based on this present study, it is recommended for future research to explore the body composition profile and handgrip strength among other Malaysian athletes. Since this type of study can help to strengthen the database of Malaysian team athletes and can be used as baseline data for future research.

AUTHORS' CONTRIBUTION

This study was designed, directed and coordinated by Nursyuhada Mohd Sukri and Aizuddin Amri Zainuddin. Aizuddin Amri Zainuddin as the principal investigator planned and provided technical guidance for all aspects of the project. Mohammad Zaihirul Syaqim Mohamed Zaidi involved with data collection. The data analysis was carried out by Mohammad Zaihirul Syaqim Mohamed Zaidi and Aizuddin Amri Zainuddin with advice from Nursyuhada Mohd Sukri and Ahmad Bisyri Husin Musawi Maliki. Nursyuhada Mohd Sukri and Ahmad Bisyri Husin Musawi Maliki contributed with the data interpretation and drafting the article. The manuscript was written by Aizuddin Amri Zainuddin and Mohammad Zaihirul Syaqim Mohamed Zaidi and commented by all authors.

CONFLICT OF INTEREST

On behalf of all authors, the corresponding author states that there is no conflict of interest. The authors have no relevant financial or non-financial interests to disclose.

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