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Association between Body Weight, Body Composition, Cardiovascular Health and Physical Activity Level in Terengganu Adults

Muhammad Hanis Qayyum Johari, Muhammad Irfan Hamdi Dzamakhsari, Nurul Afiedia Roslim, Siti Maisarah Mohd Noor, Marhasiyah Rahim, Aryati Ahmad*
Faculty of Health Sciences, Universiti Sultan Zainal Abidin, Gong Badak Campus, 21300 Kuala Nerus, Terengganu, Malaysia

ABSTRACT

This study aimed to investigate the association between Physical Activity Level (PAL) and body weight status, body composition (body fat percentage, muscle mass, total body water, visceral fat and bone mass) among adults in Terengganu. This study involved 150 participants age ranged from 19–60 years old (72 males and 78 females). PAL was determined using the International Physical Activity Questionnaire (IPAQ), while height, weight and body composition were measured using standard measurement tools. Cardiovascular health and fitness were assessed using blood pressure, heart rate and beep test. Multiple linear regression analysis was employed for data analysis. From the analysis, there was a positive association between PAL and body fat percentage independent of other factors (p=0.003), however, there was no other association with other factors. These findings contribute to our understanding of the influence between body weight, body composition, cardiovascular health and PAL in adults. Although the future study may require a bigger sample size, the finding of this study highlights the importance of physical activity to improve overall health.

Keywords: body composition, body weight status, cardiovascular health, physical activity

INTRODUCTION

The prevalence of excess weight problem has become a major public health concern worldwide, with significant implications for cardiovascular health and overall well-being. Excess body weight and increased body fat percentage, have been consistently linked to higher risks of hypertension, dyslipidemia and cardiovascular diseases (Powell-Willey *et al.* 2021; Csige *et al.* 2018; Nystoriak & Bhatnagar 2018). In parallel, according to World Health Organization (WHO), inadequate levels of physical activity exacerbate these risks, contributing to the global burden of non-communicable diseases (WHO 2022). Global trends indicate a steady decline in physical activity levels, with nearly a third of adults worldwide being physically inactive and not meeting recommended guidelines of at least 150 minutes of moderate-intensity activity per week (WHO 2024). Regular physical activity plays a protective role by supporting body weight management, regulating body composition, and enhancing overall cardiovascular function (Van Baak *et al.* 2021). Meanwhile, regular engagement in moderate to vigorous physical activity has been shown to improve cardiorespiratory fitness and reduce central adiposity (Zhang *et al.* 2020). However, previous research has demonstrated that being overweight or obese, and also physically inactive were associated with an increased risk of cardiovascular disease (Zhang *et al.* 2020). Body weight, body composition, cardiovascular health and physical activity are closely linked, as modifications in one factor may influence the others.

In Malaysia, the trend mirrors the global situation, with challenges in managing excess weight problems and cardiovascular risk factors. Modifiable risk factors such as body weight, body composition and physical activity level play an important role in the development of cardiovascular conditions (Bays *et al.* 2021; Mohd Saat *et al.* 2019). According to the National Health and Morbidity Survey (NHMS), the prevalence of overweight and obesity among Malaysian adults has steadily increased over the past decades, with corresponding rises in hypertension and other cardiometabolic disorders (Institute of

***Corresponding Author:** aryatiahmad@unisza.edu.my
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Public Health 2020). In addition, many adults in Malaysia do not meet the recommended physical activity guideline, further increasing their risk of developing cardiovascular diseases (WHO 2022).

While previous studies have examined the relationship between body weight, body composition, cardiovascular health and physical activity, limited number have explored specifically on the adult population in Terengganu, Malaysia. Terengganu is a state located on the east coast of Peninsular Malaysia, presents a unique socio-cultural and demographic profile where dietary practices and physical activity behaviours may influence health outcomes differently compared to urbanized region of Malaysia. Therefore, this study aims to investigate the relationship between body weight, body composition, cardiovascular health, and physical activity level among adults in Terengganu. The findings will help to develop future interventions by providing insights for targeted intervention programs and reducing the burden of cardiovascular disease in the region.

METHODS

Design, location, and time

This cross-sectional study was conducted from 22 March 2023 until 1 June 2023 in Kuala Nerus and Kuala Terengganu, Terengganu, Malaysia. Ethical approval was granted by Universiti Sultan Zainal Abidin Human Research Committee (UHREC) with reference no. UniSZA/UHREC/2018/72.

Sampling

This study used convenience sampling to recruit participants using various strategies including advertisements, invitations, and community programs. The inclusion criteria were adults between 18–60 years old, able to communicate and read in Malay or English and a weight stable within three months or more. Pregnant or breastfeeding women, individuals with a chronic or genetic disease or who were on a weight loss diet and athletes/trainers/coaches were excluded. Sample size was determined using single proportion formula using 56.7% prevalence of adults in Terengganu at 95% confidence interval and 5% margin of error (Department of Statistics Malaysia 2021). A total of 413 participants were required in this study after considering a 10% dropout rate.

Data collection

Potential participants were assessed for eligibility and written consent was obtained from those who agreed to participate in the study. Anthropometric, blood pressure, heart rate and body composition measurements such as height, weight, body fat percentage, total body water, visceral fat, muscle mass and bone mass were measured by a trained researcher using validated and calibrated tools. Then, participants were interviewed using a set of questionnaires consisting of two sections, namely Section A (sociodemographic data) and Section B (International Physical Activity Questionnaire ((IPAQ)). Lastly, the participant underwent a cardiovascular measurement by performing a beep test.

Anthropometric measurement. Height was measured using a portable stadiometer Seca 213 (Seca GmbH & Co. KG, Germany). Participants were barefooted and in minimal clothing to facilitate correct body positioning of the body during measurement. Afterwards, the participants were requested to stand on the baseboard with his or her heads, shoulders, buttocks, and heels touching the wall. In addition, the participants were asked to stand with heels together, arms to the side, straight legs, relaxed shoulders, and head in Frankfort horizontal plane (look straight ahead).

The participants' weight and body compositions were measured using the Tanita BC582 InnerScan Body Composition Monitor (Tanita Corporation, Japan). Participants were requested to wear light clothing and remove their shoes during the weighing process. When the screen on the weighing scale displayed a '0.0' reading on the screen, participants would step on the measuring platforms. The participants were required to stand still in the middle of the measuring platform scale to ensure that the body weight was equally distributed before the reading.

Physical activity level. The Malay version of the International Physical Activity Questionnaire (IPAQ-M) was used to assess the subjects' physical activity (Chu & Moy 2015). The IPAQ showed good correlation between activities in terms of both intensity levels and domains, ranging from 0.67 to 0.98 ($p<0.001$) with the subjective PA-Log. The Intraclass Correlation (ICC) scores revealed moderate to good correlations (ICC=0.54–0.92; $p<0.001$)

on items categorized by intensities and domains and a κ of 0.73 for total activity (Chu & Moy 2015). The questionnaire consisted of seven questions that would recall the participants' physical activity for the past seven days. Data from IPAQ-M was expressed as Metabolic Equivalents minutes per week (MET-min/week), which indicates the amount of energy expended in carrying out the physical activity. The MET-min/week was computed by multiplying the MET level by the minutes of activity per day multiplied by the number of days in the week. The physical activity level was categorised into three levels; high (>1,500 MET-minutes/week), moderate (601–1,499 MET-minutes/week) and low (>600 MET-minutes/week).

Blood pressure and heart rate. The blood pressure and heart rate were assessed using the Rossmax X1 device (Rossmax International Ltd, Taiwan). Participants were seated comfortably with their arms supported at heart level. The cuff size was adjusted, and the device was turned on. After applying the cuff and initiating the assessment, the device automatically captured the blood pressure and heart rate measurements. Multiple measurements were taken, with rest periods in between. The average of the recorded values was calculated for each participant. Blood pressure was classified according to the blood pressure categories adapted from the Clinical Practice Guidelines Management of Hypertension (Ministry of Health Malaysia 2018) as follows; optimal (≤120/80 mmHg), normal (120/80 mmHg), at risk (130/85 mmHg) and hypertension (≥140/90 mmHg). A normal resting heart rate for adults typically ranges from 60 to 100 beats per minute (Ministry of Health Malaysia 2018).

Beep test. The protocol for conducting the Beep Test involves several steps, and it was conducted by a certified or trained personnel. A suitable area measuring at least 20 meters in length was set up, with markers placed at 20-meter intervals. Participants were briefed on the purpose and procedure of the test, emphasizing the importance of giving their best effort. Participants lined up behind the start line and began running or jogging from one marker to the next, aiming to reach each marker before the beep sounds. The test progressed through levels, with the time between beeps decreasing. Participants continued until they no longer maintained the required pace or failed to reach the marker before the beep on two consecutive occasions. Generally, any level above 15 (for men) and 14 (for women) were considered excellent

Data analysis

Data were entered and analysed using the Statistical Package for the Social Sciences (SPSS) version 26 (IBM Corp. Released 2019. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp). Descriptive statistics were used to describe the socio-demographic characteristics, anthropometric, body weight status, body composition, physical activity, and cardiovascular health. Numerical data were presented as Mean (SD) or Median (IQR) based on their normality distribution. Categorical data were presented as frequency (percentage). Multiple linear regression tests were used to determine the association between physical activity, body weight status, body composition and cardiovascular health.

RESULTS AND DISCUSSION

A total of 150 participants participated in the study (36% response rate). Of all, 62 participants (48.0%) were men, while 78 individuals (52.0%) were women. The majority of participants were Malay (98.7%), followed by one individual each (0.7%) representing the Indian and Chinese ethnic groups. For occupation, 105 participants (70.0%) were from the government sector, while 45 participants (30.0%) were university's students (Table 1).

Anthropometric measurements, physical activity and cardiovascular health of participants

The participants had a mean height of 1.6±0.1 m and a mean weight of 70.9±18.1 kg, with an average BMI of 26.6±5.8 kg/m2. BMI classifications showed that 3.3% of participants were underweight, 22.7% fell within the normal range, 16.7% were overweight, 22% were classified as obese class I, and 17.3% were classified as obese class II. In terms of body composition, men had a mean body fat percentage of 23.9±7.8 %, while women had a mean of 35.0±7.8 %. The average total body water was 53.4±3.1 for men and 46.9±3.7 for women.

The overall mean visceral fat was 8.8±5.0. Furthermore, the study observed that men had

Table 1. Basic characteristics of participants

Characteristics (n=150)	n (%)
Age (years) (Mean±SD)	31.2±8.9
Gender	
Male	72 (48.0)
Female	78 (52.0)
Race	
Malay	148 (98.7)
Indian	1 (0.7)
Chinese	1 (0.7)
Occupation	
Goverment staff	105 (70.0)
University student	45 (30.0)

Data are presented in Mean±Standard Deviation (SD) or frequency (%)

a mean muscle mass of 55.5±8.8 kg, whereas women had a mean of 44.3±50.7 kg. Lastly, men had a mean bone mass of 3.0±0.5 kg, whereas women had a mean of 2.3±0.4 kg (Table 2).

Regarding physical activity level, 60 (40.0%) of the respondents engaged in low-intensity physical activity, 54 (36.0%) engaged in moderate-intensity physical activity, and only 36 (24.0%) engaged in high-intensity physical activity. The mean heart rate was 87.7±14.1 beats per minute (bpm), mean systolic blood pressure was 127.3±16.08 mmHg, and mean diastolic blood pressure was 80.3±10.6 mmHg. The performance of the participants in the beep test was categorised in several levels; 108(72%) of participants were classified as "very poor," 23 (15.3%) as "poor," 8 (5.3%) as "fair," 7 (4.7%) as "average," 1 (0.7%) as "good," and 3 (2.0%) as "very good."

The role of physical activity level is well recognised, particularly in the prevention of non-communicable diseases such as CVD, cancer, obesity, and depression (Abu *et al.* 2020). According to research, engaging in regular physical activity can provide up to 75% of the maximal benefit in terms of disease risk reduction (Kraus *et al.* 2019). In contrast, multiple studies have shown that physical inactivity contributes significantly to the worldwide illness burden. Physical inactivity is responsible for more than 7% of all deaths, including those caused by CVDs, and up to 8% of noncommunicable diseases (Katzmarzyk *et al.* 2022). Our study found that 40% of participants had low PA, which is comparable to most NHMS survey reports (Institute of Public Health 2020). It is also similar to a previous study which reported almost all the participants (90.5%) engaging in low physical activity levels (Mohd Saat *et al.* 2021). However, the result is contradicted by Saat *et al.* (2021) who reported most university students engaged in moderate physical activity (54.2%) followed by high physical activity (25.8%) and low physical activity (20%) level.

Association between body weight status, body composition, cardiovascular health and physical activity

Based on the multiple linear regression analysis, there was a significant linear relationship between physical activity level (total score of IPAQ) and body fat percentage (p=0.003). It is observed that for every 1 unit increase in body fat %, there will be an 82.034 unit decrease in the IPAQ score (Table 3).

Our findings demonstrated that there was no significant association between physical activity level and body weight status. This is contradicted with a systematic review by Cleven *et al.* (2020) showing that there was a relationship between physical activity and a decreased risk of incident diabetes, CHD, and obesity. The study reported that in 20 studies (77%), higher levels or amounts of physical activity were linked to a lower risk of new onset of the corresponding illnesses while four studies found that reduce physical activity levels (15%) were correlated with a higher risk of disease development (Cleven *et al.* 2020). The association between physical activity level and body weight status may also influenced by other factors including body composition. For instance, two individuals with the same BMI may have varying proportions of muscle and fat, which may have an impact on their health in various ways (Mohajan & Mohajan 2023). Furthermore, genetics may also be a factor that affects BMI. Body weight and body composition, and how physical exercise impacts BMI can all be influenced by a person's genetic makeup. Regardless of their degree of exercise, some

Table 2. Anthropometric measurements and cardiovascular health of participants

Characteristics (n=123)	Mean±SD	n (%)
Height (m)	1.6±0.1	
Weight (kg)	70.9±18.1	
BMI categories*		
Underweight (BMI: ≤17.5 kg/m^2)		5 (3.3)
Normal (BMI: 17.5–22.9 kg/m^2)		34 (22.7)
Overweight (BMI: 23.0-29.9 kg/m^2)		25 (16.7)
Obese I (BMI: 30.0–40.0 kg/m^2)		33 (22.0)
Obese II (BMI: ≥40.1 kg/m^2)		26 (17.3)
Body fat percentage*		
Men	23.9±7.8	
Women	35.0±7.8	
Total body water*		
Men	53.4±3.1	
Women	46.9±3.7	
Visceral fat*	8.8±5.0	
Muscle mass (kg)*		
Men	55.5±8.8	
Women	44.3±50.7	
Bone mass (kg)*		
Men	3.0±0.5	
Women	2.3±0.4	
Physical activity level		
Total IPAQ	1,923.4±2,151.6	
Low-intensity		60 (40.0)
Moderate-intensity		54 (36.0)
Vigorous-intensity		36 (24.0)
Heart rate	87.7±14.1	
Blood pressure (mmHg)		
Systolic	127.3±16.08	
Diastolic	80.3±10.6	
Physical fitness	3.2±2.2	
Very poor		108 (72.0)
Poor		23 (15.3)
Fair		8 (5.3)
Average		7 (4.7)
Good		1 (0.7)
Very good		3 (2.0)

Data are presented in Mean±Standard Deviation (SD) or frequency (%); BMI: Body Mass Index; IPAQ: International Physical Activity Questionnaire Height, weight, BMI, body fat percentage, total body water, visceral fat, muscle mass, bone mass

people may have a hereditary propensity to gain weight or have a higher BMI (Lin & Li 2021). Furthermore, genetic and environmental factors, such as food and physical activity, interact rather than function on their own. A previous study conducted by Westbury *et al.* (2023) suggested

Table 3. Relationship between selected characteristics (BMI, body composition and cardiovascular fitness) and physical activity

Variables	Simple linear regression		Multiple linear regression	
	β (95% CI)	*p*	β (95% CI)	*p*
Age	-41.87 (-83.39–-0.36)	0.048*	-46.29 (-92.5–-0.1)	0.049*
BMI	-14.29 (-80.15–51.57)	0.668	76.44 (-19.4–172.3)	0.117
Body fat %	-54.87 (-93.79–-15.95)	0.006*	-82.03 (-135.2–-28.8)	0.003*
Heart rate	-17.85 (-44.24–8.54)	0.183	-18.21 (-46.2– 9.8)	0.201
Blood pressure				
Systolic	-4.42 (-27.64, 18.81)	0.708	-1.94 (-39.1, 35.2)	0.918
Diastolic	3.44 (-31.83–38.71)	0.848	10.81 (-43.0–64.7)	0.691
Physical fitness	190.02 (22.43–357.62)	0.027*	-1321.48 (-4,504.4–1,861.4)	0.413
Constant			4,929.45 (1,219.5–8,639.4)	0.010

*Simple and Multiple linear regression was applied and significant at levels p<0.05; BMI: Body Mass Index; CI: Confident Interval

that people who live in obesogenic environments and have high-calorie diets and sedentary lifestyles may be more likely to gain weight if they have certain genetic variations related to obesity. Diet is important for managing weight, and physical activity may not have a substantial impact on BMI if it is not combined with a good diet (Jezewska-Zychowicz *et al.* 2019).

Inadequate physical activity is well-known to raise the risk of cardiovascular disorders such as hypertension, obesity, and heart disease (Cleven *et al.* 2020). CVDs accounted for the largest percentage of deaths recorded in 2018, underlining the country's urgent need for effective preventative policies and interventions (WHO 2021). It has been demonstrated that an increase in heart rate of 10 bpm is related to a 20% increase in the risk of cardiac death, and this increase in risk is comparable to that reported with an increase in systolic blood pressure of 10 mm Hg (Perret-Guillaume *et al.* 2009). Similarly, in Okin *et al.* (2010) LIFE study of hypertensive patients, a 10 bpm higher HR was related to a 25% increased risk of cardiovascular death and a 27% increased risk of all-cause mortality. However, this study failed to find the relationship potentially due to small sample size.

The association between physical activity level and body weight status, body composition and cardiovascular health were analysed using multiple linear regression. The findings revealed that age and body fat percentage exhibited a significant linear relationship. This is supported by Suryadinata *et al.* (2020), suggesting that these factors play a vital role in determining physical activity levels. The study had strengths in its comprehensive assessment approach, utilizing multiple measures to evaluate physical activity levels, beep test performance, and cardiovascular health outcomes. Validated instruments and objective measurements enhanced the reliability and validity of the findings. However, limitations included the potential for bias in self-reported physical activity levels and the limited sample size. This study has a low response rate, due to majority of participants were students, which may limit the generalizability of the findings. Further research with larger sample sizes and broader geographical and sociodemographic representation is warranted to strengthen the understanding of the true relationship between physical activity and cardiovascular health outcomes.

Future studies on the association between physical activity and cardiovascular health should consider longitudinal prospective studies to establish causal relationships and identify potential confounding factors over time. Incorporating qualitative research methods alongside quantitative measures would provide deeper insights into socio-cultural and environmental factors influencing physical activity behaviour. Furthermore, expanding the scope to include other determinants of cardiovascular health,

such as diet, stress, and genetics, would provide a holistic understanding. Interventions targeting specific populations, utilizing technology-based approaches, and addressing socioeconomic disparities are warranted to promote physical activity and improve cardiovascular health.

CONCLUSION

In conclusion, this study discovered significant linear relationship between body fat percentage and physical activity level. Future interventions should consider a comprehensive approach that addresses multiple determinants of health, including age, BMI, socioeconomic factors, cultural norms, and environmental influences, to promote overall well-being and improve health outcomes related to body weight, body composition, cardiovascular health and physical activity.

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DECLARATION OF CONFLICT OF INTERESTS

The authors have no conflict of interest

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