AEROBIC FITNESS LEVEL AND ITS ASSOCIATION WITH BMI AND BODY FAT PERCENTAGE AMONG MALE UNIVERSITY STUDENTS

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Abstract

Introduction: The maximum oxygen uptake capacity (VO_2max) is one of the best indicators of aerobic fitness. Not only that, it also helps in identifying future health risks associated with low VO_2max. Aerobic fitness and body fat percentage are closely connected and related to the risk of the development of cardiovascular disease. This research aimed to evaluate the association between aerobic fitness level with body fat percentages (BFP) and body mass index (BMI). **Methods:** A cross-sectional study was conducted among 60 undergraduate male students at the IIUM Kuantan Campus. The Cooper's 12-minute walk-run test was used to measure VO_2max to estimate the aerobic fitness level. **Results:** The percentile value by Cooper Institute, the mean VO_2max (ml.kg-1.min-1) of the study participants was 34.22 ± 6.98, which was in the 'poor' category. Meanwhile, the mean BFP (17.42 ± 5.80%) and mean BMI (22.96 ± 3.89kg/m^2) were categorized as normal. There was a significant negative correlation between BMI and aerobic fitness level, VO_2max ($r = -0.296$, $p = 0.021$). In addition, there was a significant negative correlation between BFP and VO_2max ($r=-0.470$, $p<0.0001$). **Conclusion:** This study indicates that the higher the BFP, the lower the aerobic fitness. On the other hand, a higher BMI level was associated with a lower aerobic fitness level. Interventions are needed to increase awareness regarding the importance of maintaining healthy body composition and aerobic fitness levels among university students in reducing the risks for chronic diseases.

Keywords: Aerobic fitness, Body fat percentage, Body mass index, VO_2max

Introduction

Obesity is becoming a global epidemic, and Malaysia has the highest prevalence of obesity among adults in Southeast Asia. In the recent National Health and Morbidity Survey, half of the adult population were reported to be overweight (30.4%) or obese (19.7%) (Institute for Public Health, 2020). Defined as excessive accumulation of fat, obesity is a health concern as it is a risk factor for non-communicable diseases like CVD, type 2 diabetes, and several cancers (Drenowatz, et al., 2014). In addition, a sedentary lifestyle may also contribute to fat accumulation and lead to obesity and cardiovascular diseases. Based on the findings of epidemiological studies included in a systematic review, it may be concluded that an active lifestyle is associated with a reduced risk for developing CVD (Adams & Linke, 2019).

Information from cross-sectional and prospective studies states that involvement in exercise declines significantly between adolescence and adulthood (Zanovec, Lakkakula, Johnson, & Turri, 2009). As stated by the WHO (2006), it is estimated that less than one-third of people are sufficiently active. Nearly half of those aged 12-21 years were not vigorously active on a regular basis (Maruf, Akosile, & Umunah, 2012). Thus, lower involvement in physical activity will lead to excessive accumulation of fat, which may impair health. (Zanovec, Lakkakula, Johnson, & Turri, 2009).

According to Zanovec, et. al, (2009), most studies show that BMI is a rational measure of adiposity in healthy adults as the use of BMI assumes all the individuals have the same relative body fatness independent of age, gender and race. However, BMI may not be able to determine the accurate picture of health and is incomplete as a technique to determine the risk factors for heart disease, diabetes, and other chronic conditions. This is because, some people with healthy weight may have excess body fat which is highly correlated to diabetes, high blood pressure and heart disease (Schneider et al, 2017). On the other hand, BFP is a measurement of body composition that determines the weight of the body fat which can be found under the skin (subcutaneous fat), essential fat (helps to protect internal organ, stores fuel for energy and regulate important body hormones), excess storage of fat and non-essential body fat (Scott, 2018). The average BFP for men is 18% – 24% and for women is 25% - 31%. Meanwhile, the BFP more or equal to 25% for men and more or equal to 32% for female are considered obese as stated by the American Council on Exercise (2018).

Lower general and central adiposity among adults (even after controlling for total physical activity energy expenditure) were contributed by their engagement in greater amounts of free-living vigorous physical activity. An intervention study of adults showed that there was a greater reduction in body fat among the study participants who were practicing high intensity physical training compared to moderate-intensity physical training. Although the high intensity physical training resulted in a ,more apparent improvement in cardiovascular fitness, there was a similar decline of skinfold fat in the low and high intensity physical training group during physical training as suggested by a juvenile intervention study that controlled for energy expenditure. In a study that used VO2max as the index of cardiovascular fitness at baseline, those youths who did not achieve VO2max were heavier than those who did. , (Gutin et al., 2002).

Based on previous research, Razak, Maizi & Muhammad (2013), stated that, there is a significant reverse relationship between students' VO2max levels and BFP. They also found that physical fitness among college students was decreased while body fatness was elevated. In addition, the findings by Demirkan, Can, & Arslan (2016), showed that males have much higher aerobic fitness than females due to their lower fat mass and other factors mainly related to the cardiac size and oxygen carrying capacity. They also identified a strong connection between BFP and VO2max test values for 12 minutes walk/run test (Cooper's 12-minute walk-run test).

Studies on the relation of aerobic fitness level with body composition measures such as BMI and BFP among young adults are scarce. Thus, this research aimed to examine the association between aerobic fitness level with BFP and BMI among undergraduate students at the International Islamic University Malaysia (IIUM) in Kuantan, Pahang, Malaysia.

MATERIALS AND METHODS

Study Participants

A total of 60 undergraduate male students were recruited by convenient sampling. The inclusion criteria for this study included male gender, undergraduate students, and was physically healthy. Individuals who were female, matriculation or postgraduate students, or not physically healthy, were excluded from the study. The sample size for this study was determined by using the single proportion formula yielded a suggested number total of 65 study participants, including a 10% attrition rate.

The study protocol was approved by the IIUM Research Ethics Committee (IREC 2019-075). Informed consent was obtained from each study participant before the study commencement.

Anthropometrics Measurement

Height was measured by using a SECA 763 digital column scale with a stadiometer while weight was measured by using OMRON HBF-375 digital body composition and scale. Based on height and weight, body mass index (BMI) was calculated using the formula BMI = kg/m^2, where kg is a person's weight in kilograms and m^2 is their height in meters squared. The WHO classification of BMI for normal, overweight and obesity are determined as 18.5 - 24.9, 25 - 29.9 and > 30 kg/m^2, respectively (WHO, 1998). The BFP was measured by using OMRON HBF-375 digital body composition and scale.

Aerobic Fitness Test (VO_2max) and Classification

Each study participant was requested to run a 400m round track for 12 minutes at the IIUM Sports Complex. They were encouraged to try and run as many laps as they could. The total number of laps was recorded, and the finishing point was marked. The total distance (in meters) covered in the 12-minute duration was calculated by multiplying the number of complete laps by 400m plus the distance covered in the final incomplete lap. The test was repeated twice, and the average was recorded. The duration (12 minutes) and average distance (in meters) were inserted into the Cooper Test formula to calculate VO_2max: VO_2max (ml.kg-1.min-1) = (distance in meters – 504.9)/44.73 (Cooper, 1968). This test is used as a field test for determining aerobic fitness.

The VO_2max value obtained was classified into aerobic fitness ratings: Very Poor < 33.0ml/kg/min; Poor 33.0-36.4ml/kg/min; Fair, 36.5-42.4ml/kg/min; Good 42.5-46.4ml/kg/min; Excellent 46.5-52.4ml/kg/min; and Superior, >52.4ml/kg/min based on the age range (Cooper, 1968). For this study, the range was between 20-29 years old, according to the normative data for VO_2max.

Statistical Analyses

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 21 (IBM Corporation, Armonk, New York, USA). Numerical data were presented as mean, standard deviation (SD), median and range. The demographic data were presented using descriptive analysis. The correlations between aerobic fitness (VO_2max) and BMI or BFP were determined using Spearman correlation.

RESULTS

Demographic Data

The age of the study participants who participated in this research ranged from 20-26 years (mean ± SD**:** 23.02 ± 1.02). The mean and SD of the participants' height were 168.9 ± 5.2 cm, whereas their mean weight was 65.7 ± 13.0 kg. The mean and SD of the body mass index were 23.0 ± 3.9 kg/m^2. Based on the WHO's BMI classification, four of the students were categorized as underweight, 42 were normal weight, nine were overweight, and five were obese.

Body Mass Index and VO_2 max

The mean body fat percentage (BFP) of the study participants was 17.4 ± 5.8%. On the other hand, the mean of maximum oxygen uptake capacity (VO_2max) of the subjects in this research was estimated to be 34.22±6.98 (mL/kg/min) using a Cooper-12-min walk/run test.

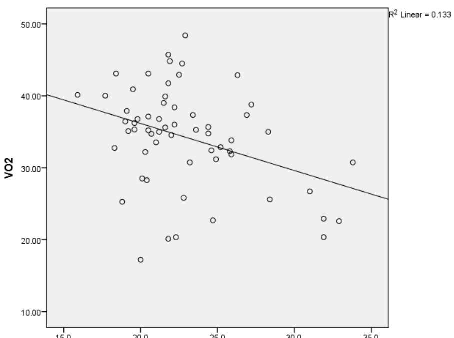

Figure 1. The scatterplot between BMI and VO_{2max} (n=60)

An examination of the scatterplots suggested the presence of linearity for the two variables for the measurements, BMI and VO_2max of data analyzed. Figure 1 shows a scatterplot between BMI and VO_2max which indicate there is linear relationship between the two variable. Thus, the higher the BMI, the lower the VO_2max. The presence of linearity for the measurements permitted the use of correlation coefficients. There was a weak negative correlation between BMI and VO_2max, which was statistically significant, r = -0.296, p = 0.021.

Body Fat Percentage and VO_2max

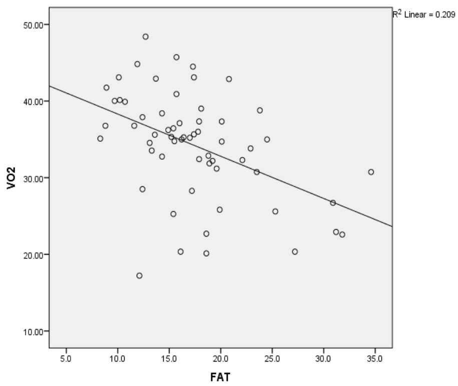

Figure 2. The scatterplot between BFP and VO2max (N=60)

An examination of the scatterplots suggested the presence of linearity between the BFP and VO_2max (Figure 2). This permitted the use of correlation coefficients (r=-0.470, p<0.0001), indicating that with an increase in the BFP, there was a significant reduction of the VO2max value.

Body Fat Percentage and BMI

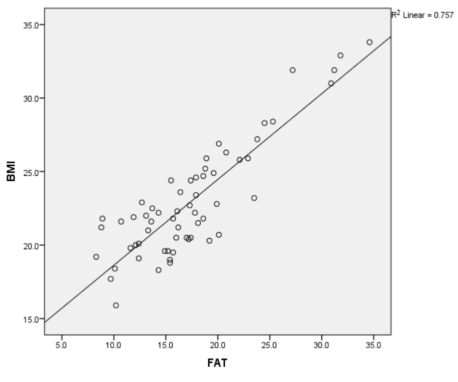

Figure 3. The scatterplot between BFP and BMI (N=60)

Figure 3 shows a scatterplot between BFP and BMI values, showing a significant, positive linear relationship between the two variables (R=0.760, P<0.0001). Thus, this indicates that the higher the BFP, the higher the BMI.

Discussion

The current research aimed to evaluate the relationship between BFP and BMI and aerobic fitness. VO_2max (ml/kg/min) is one of the best measures of fitness for exercise. However, measuring VO_2max is not only intended to predict fitness for exercise; it also helps in identifying future health risks associated with low VO_2max. The mean and SD of VO_2max in this research were estimated at 34.22±6.98 (mL/kg/min) using a Cooper-12-min walk/run test. It indicates that most of the study participants have poor aerobic fitness levels. This finding was supported by other researchers such as Daneshmandi et al. (2013), who found VO_2max among their study participants to be 35.95±7.39 mL/kg/min, and Rafieepour et al. (2014) with VO_2max of 32.60±10.39 mL/kg/min. In addition, the VO_2max in the current study was lower than other studies conducted among male population; as reported by Mondal and Mishra (2017) (43.25±7.25mL/kg/min), Sterkowicz et al, 2011 (41.9±4.62 mL/kg/min), and Ashfari et al. (2019) (44.01 ± 4.75 mL/kg/min).

Aires et al. (2010) showed that physical activity influenced cardiorespiratory fitness and cardiorespiratory fitness influenced BMI. Therefore, cardiorespiratory fitness is a mediator in the relationship between physical activity and BMI. Leyk et al. (2006) demonstrated an increase in body weight and decrease in fitness in students aged 17 - 26 years. The researchers reported an inverse relationship between inflammatory indices and cardiovascular fitness (Arabmokhtari et al., 2018).

In the current study, BMI was negatively associated with aerobic fitness levels. This is in line with what others have found earlier. According to Mondal and Mishra (2017), BMI showed a significant negative correlation with VO2max (r= -0.323, p=0.017). Similarly, Ashfari et al. (2019) demonstrated a significant negative correlation between BMI and VO_2max in their study (r = 0.919, p≤ 0.001). This correlation suggests that with increasing BMI, the aerobic fitness capacity of individuals decreases. A negative correlation between BMI and VO_2max was also reported among children (Hsieh et al, 2014). The authors stated that Taiwanese children with a normal BMI generally have a better cardiorespiratory fitness level than underweight, overweight, or obese children. Regarding the reverse relationship between BMI and VO_2max, several studies have referred to the effect of weight and body composition on VO_2max, which might be due to the physiological effects of weight gain. Weight gain and BMI increases the body's need for blood supply to the tissues, and owing to the limited heart's capacity, blood is not supplied well to tissues; therefore, the oxygen available to the tissues is reduced (Ashfari et al., 2019).

According to the percentile value by Cooper Institute, the mean VO_2max (ml.kg-1.min-1) of males (34.22 ± 6.98) was in the 'poor' category. On the other hand, the subjects' mean BFP (17.42 ± 5.80) was considered normal based on the WHO classfication. Lack of exercise or sedentary lifestyle of the subjects may be the cause of this low aerobic fitness level even though the average BFP was normal. In this regard, the relationship between BFP and aerobic fitness level in this study showed a significant relationship between these variables. In addition, the correlation of BFP and VO_2max was strong (r= -0.470, p= 0.0001).

According to Ashfari, (2019), a young adult with an increased BFP would have lower aerobic capacity than someone with low BFP. This is due to the increased fat deposition around the heart, which usually occurs due to obesity. This might reduce the heart capacity and the ability of performing the aerobic fitness test. This finding supports the study of Ostojic, et al. (2011), who found that there was a significant relationship between the BFP and VO_2max ($r=-0.76$; $p<0.05$), with a strong negative relationship between aerobic fitness and body fatness.

There was a higher correlation coefficient of BFP and VO_2max than that of BMI and VO_2max. The result shows there is a strong correlation between the BFP and VO_2max whereas there is a weak correlation between BMI and VO_2max. This finding indicates obesity in terms of BFP is a better parameter than BMI for the prediction of the low cardiorespiratory functional status of young adults. This statement was supported by Mondal and Mishra (2017), who demonstrated a weak negative correlation between BMI and VO_2max ($r= -0.3232$, $p=0.0171$), but BFP showed a strong negative correlation ($r= -0.7505$, $p<0.001$) with VO_2max. Increased body fat is associated with a decreased level of VO_2max in young adults. Thus, obesity in terms of BFP is a better parameter than BMI for the prediction of low VO_2max. Therefore, during exercise prescription, if feasible, measurement of total body BFP is a more acceptable parameter than BMI. This is because, young adults who who have normal BMI, do not necessarily have lower BFP compared to those who are obese.

An increase in regular physical activity or exercise may help decrease the BFP, which may relatively increase the VO_2max. The beneficial effect of exercise on the increment of VO_2max has been established in a study by Shete et al. (2014) where the mean BFP in athletes was 24.11 ± 1.83% and 29.31 ± 3.86%in non-athletes. This shows that active individuals such as athletes, have higher VO2max compared to non-athletes. Thus, a suggestion to reduce BFP by increasing physical activity or exercise would also help to decrease health risks in young adults.

Conclusion

This study indicated that higher BMI and BFP values are associated with lower aerobic fitness levels. Interventions are needed to increase awareness regarding the importance of maintaining healthy body composition and aerobic fitness levels among young adults to reduce the risks for chronic diseases.

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