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Relationship between assesment of physical activity with body mass index and maximum oxygen volume in adult men with overweight and obesity

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ABSTRACT

Background. Non-communicable diseases (NCDs) are the leading cause of early adult mortality, often originating in adolescence. Obesity a prevalent NCD, commonly develops during youth and can measured by body mass index (BMI).

Objectives. This study was to describe the relationships between physical activity, as defined by the International Physical Activity Questionnaire (IPAQ), BMI, and maximum oxygen consumption (VO2max) in adult men who are overweight or obese.

Materials and methods. This descriptive study utilized the IPAQ-SF, BMI, and VO2max data from 22 medical records of adult men who were overweight or obese, selected using a purposive sampling approach.

Outcomes. Physical activity and BMI are negatively correlated, with a p-value of 0.000 and a Pearson correlation coefficient of -0.989. Statistical significance is indicated by the p-value of 0.000, and the Pearson correlation coefficient of 0.884 shows a strong positive association between VO2max and physical activity. BMI and VO2max are negatively correlated, with a p-value of 0.000 and a Pearson correlation coefficient of -0.896.

Conclusion. The study indicates a relationship between physical activity and BMI, as well as between physical activity and VO2max. Additionally, there is a relationship between BMI and VO2max. Overall, physical activity, BMI, and VO2max are interrelated in overweight or obese adult men.

Keywords: BMI, obesity, overweight, physical activity, VO2max

Abbreviations (in alphabetical order):

AMPK – adenosine monophosphate-activated protein kinase
BMI – body mass index
CaMKII – Calcium/calmodulin-dependent protein kinase II
IPAQ – International Physical Activity Questionnaire
NCD – non-communicable diseases
NEAT – non-exercise activity thermogenesis

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p38MAPK – p38 Mitogen-Activated Protein Kinases
ROS – reactive oxygen species
VO2max – maximum oxygen consumption
WHO – World Health Organization

INTRODUCTION

Non-communicable diseases (NCDs) are the leading cause of early adolescent death (World Health Organization (WHO) [1]. Obesity is one of the most common NCD and is associated with metabolic syndrome, making it a significant public health problem. Obesity can develop in adults, adolescents, and children. More than 1.4 billion adults are overweight, and 500 million adults are obese [2]. Globally, adults over the age of 18 have a high prevalence of overweight, with 39 percent of men and 40% of women affected, while 11% of men and 15% of women are obese [3]. The 2018 Risk Basic Survey results show that about 13.6 % of people over 18 years of age are overweight and 21.8% of adults are obese [4]. Excessive eating, low physical activity, and genetic factors are the leading causes of obesity [5].

Several factors can contribute to obesity, including genetic, environmental, pharmaceutical, and hormonal factors [6]. A study by Kim and Shin (2020) found that gender influences fat distribution and function: men tend to accumulate more visceral fat, resulting in a typical android body shape associated with an increased risk of cardiovascular disease, while women accumulate more subcutaneous fat (prior to menopause), which offers protection against the negative effects of obesity and metabolic syndrome. However, after menopause, this protective effect diminishes, increasing metabolic risk to a level comparable to that of men [6].

The body mass index (BMI) remains as a valuable measure that serves as a basic benchmark for assessing obesity risk [7]. According to the obesity criteria set by the Western Pacific Region of the WHO, BMI classifications can vary by race. Specifically, 20 percent of individuals are considered overweight with a BMI between 23.0 and 24.9, 20% are classified as grade I obese with a BMI between 25.0 and 28.9, and 2% are classified as grade II obese with a BMI higher than 30.0 [2].

Physical activity, as defined by the WHO, plays crucial role to any bodily movement that requires energy expenditure, this includes activities such as work, play, study, travel, recreation, and exercise [6]. Inactivity can contribute to the development of chronic conditions like hypertension and obesity [6]. On the other hand, engaging in moderate to vigorous physical activity can promote good health and help prevent various diseases [8]. To measure the physical activity and life style, we often used The International Physical Activity Questionnaire (IPAQ) [9]. A study by Dharmansyah and Budiana (2021) found that the Indonesian version of the IPAQ-short form has a high reliability score of 0.884 and a validity correlation with the accelerometer of 0.00 [11]. The IPAQ has a medium data validity, ranging from 0.430 to 0.557 [10]. In this study we want to give a description about the relationship between physical activity, as we measure with IPAQ, BMI, and maximum oxygen consumption (VO2max) in adult men who are overweight or obese.

MATERIALS AND METHODS

Samples

The study was conducted at the Medical Rehabilitation Facility of Dr. Soetomo General Academic Hospital, Surabaya, in January 2024, using a cross-sectional study design. The aim was to analyze the relationship between physical activity, as measured by the IPAQ, and BMI and VO2max in adult men who are overweight or obese. The subjects of the study were 22 medical records of adult men with overweight or obesity, selected using purposive sampling techniques. The parameters evaluated were physical activity, assessed using the IPAQ-SF questionnaire, and a data sheet containing BMI and VO2max information. The evaluation in this study was conducted only once.

Inclusion and exclusion criteria

We used purposive sampling to select the sample. The inclusion criteria were an age range of 18 to 55 years and a BMI higher than 22.9 kg/m². The exclusion criteria included participants who had engaged in a regular aerobic exercise program at least twice a week, whether at home, work, or a fitness center, within the last two months.

Statistical analysis

The statistical tests in this study included a normality test using the Kolmogorov-Smirnov method. The data were then analyzed using SPSS v22.0. The Pearson correlation test was applied for normally distributed data, while the Spearman correlation test was used for non-normally distributed data, to assess the relationship between physical activity, BMI, and VO2max.

Ethical clearance

The protocol for this study was approved by the Research Ethics Committee of Dr. Soetomo General

Academic Hospital, under approval number 0884/ KEPK/I/2024.

OUTCOMES

This study give a describe about the relationships between physical activity, body mass index (BMI), and maximum oxygen consumption (VO2max) in overweight or obese adult men. The dataset comprised 22 medical records of adult men at the Medical Rehabilitation Facility of Dr. Soetomo General Academic Hospital, Surabaya. Participants were chosen according to defined inclusion criteria, and those fulfilling the exclusion criteria were omitted. The individuals had a mean age of 32.18 ± 3.33 years, an average BMI of 28.25 ± 3.27 kg/m², an average VO2max of 28.23 ± 3.16 ml/kg/min, and an average IPAQ-SF score of 2030 ± 644.26 METs.

Before statistical analysis, the data was subjected to normality testing by the Kolmogorov-Smirnov test. The results (Table 1) demonstrated that the data followed a normal distribution, with p-values of 0.737 for BMI, 0.378 for VO2max, and 0.237 for IPAQ-SF. The Pearson correlation test was employed to evaluate the relationships between these variables, assuming a normal distribution.

TABLE 1. Subject characteristics and normality test

	Mean + SD	p-value
Age (years)	32.18 + 3.33	0.315*
BMI (Kg/m²)	28.25 + 3.27	0.737*
VO2max (ml/kgBB/min)	28.23 + 3.16	0.378*
IPAQ	2030 + 644.26	0.237*

Kolmogorov-Smirnov test, normal data distribution when p >0.05

TABLE 2. Pearson correlation statistics test

		BMI	VO2max	IPAQ
BMI	Pearson Correlation		-0.896*	-0.989*
	Sig. (2-tailed)		0.000*	0.000*
VO2max	Pearson Correlation	-0.896*		0.884*
	Sig. (2-tailed)	0.000*		0.000*
IPAQ	Pearson Correlation	-0.989*	0.884*	
	Sig. (2-tailed)	0.000*	0.000*	

Pearson correlation test, significant when p < 0.05

Table 2 yielded significant results, exhibiting a p-value of 0.000 for all correlations: BMI with VO2max, BMI with IPAQ, VO2max with BMI, VO2max with IPAQ, IPAQ with BMI, and IPAQ with VO2max. BMI had a strong negative connection with VO2max (Pearson correlation = -0.896) and a very strong negative correlation with IPAQ (Pearson correlation = -0.989). VO2max had a negative connection with BMI (Pearson correlation = -0.896) and a positive correlation with IPAQ (Pearson correlation = 0.884). IPAQ had a negative connection with BMI (Pearson correlation = -0.989) and a positive correlation with VO2max (Pearson correlation = 0.884).

DISCUSSION

Recently, this study investigated the relationship between physical activity, BMI, and VO2max among overweight or obese adult men. The findings emphasize the consequences of excess body mass on cardiorespiratory fitness as well as the levels of physical activity. The subjects studied had an average BMI of 28.25 ± 3.27 kg/m², which indicates that they were overweight and obese. This coincides with the available information which describes that people above the BMI of 22.9 are at a risk of getting physical metabolic defects. The VO2max of the respondents averaging 28.23 ± 3.16 ml/kg/min, reflected suboptimal levels of cardiorespiratory fitness, particularly among working-age populations such as 30-39 years of age. These findings are in line with past research which showed that individuals with obesity are likely to have a low aerobic capacity which comes with adverse health impacts along with increased vulnerability to chronic diseases such as cardiovascular disease and metabolic diseases [11].

Despite the participants' moderate physical activity levels, as indicated by an average METs score of 2030 ± 644.26 based on the International Physical Activity Questionnaire (IPAQ), their VO2max readings remained suboptimal. This suggests that even moderate physical activity may not sufficiently counteract the adverse effects of increased BMI on cardiorespiratory fitness [9]. The results underline the need for interventions which will not only encourage men to be physically active but also seek to enhance cardiorespiratory fitness through prescribed aerobic exercise tailored to the individual capabilities. Additionally, the study highlights the importance of evaluating both BMI and VO2max when assesing the health risk associated with obesity. While BMI is a useful indicator of body weight and related health risks, VO2max offers a more accurate assessment of cardiovascular health and physical fitness.

A two-way relationship between physical activity and BMI

The data analysis produced a p-value of 0.000 and a Pearson correlation coefficient of -0.989, signifying a robust negative link between physical activity and BMI. This indicates a reciprocal relationship: elevated physical activity correlates with decreased BMI, whereas increased BMI is associated with diminished physical activity. This conclusion is consistent with other research indicating that non-obese persons generally participate in physical activity more often than their obese counterparts. An energy imbalance transpires when energy consumption surpasses energy expenditure, heightening the risk of overweight, obesity, and hypertension [12]. Research conducted by Kananda and Megawati (2020) identified physical activity as a significant factor affecting BMI [13]. Other variables, including genetics (hereditary obesity) and dietary habits, can also influence BMI, along with additional factors such as age, gender, and physical activity [13]. The correlation between inadequate physical activity and the risk of overweight and obesity indicates a close interrelation between BMI and physical activity [14].

A cohort study demonstrates that a reduction in physical activity frequently precedes the development of obesity, although additional studies propose that obesity may inhibit physical activity [15]. Non-exercise activity thermogenesis (NEAT) encompasses minor motions throughout the day that involve light to moderate physical activity, including the use of energy-efficient devices or extended periods of sitting. Participating in NEAT can aid in weight maintenance [16,17]. Reduced physical activity can result in the buildup of energy as adipose tissue, and persistently low activity levels may contribute to an elevated BMI [13]. According to this research, frequent physical exercise is crucial for sustaining a healthy BMI (Figure 1) [18]. An inverse correlation exists between physical activity and BMI; when physical activity diminishes, BMI often escalates, and conversely [19].

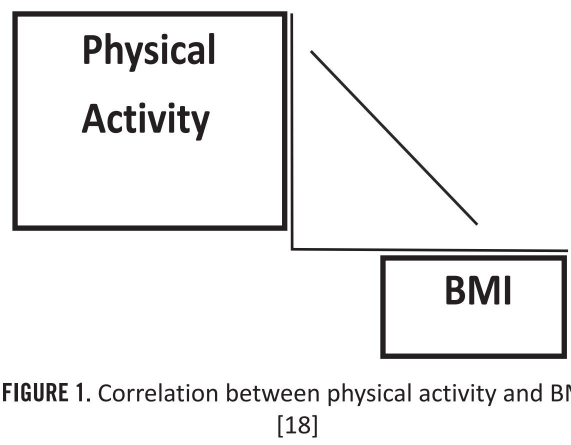

FIGURE 1. Correlation between physical activity and BMI [18]

Gender is a crucial determinant of physical activity levels [14]. Danu et al. (2023) discovered that men participate in greater amounts of vigorous physical activity [20]. A study by Yuliadarwati et al. (2020) further corroborates this, indicating that although there are no substantial variations in physical activity levels between boys and girls prior to puberty, men generally have elevated activity levels compared to women post-puberty [21]. Men generally consume more calories than women, even in the absence of physical activity, owing to their superior muscular mass, which results in elevated calorie expenditure [22].

Enhanced cardiac efficiency is attained through improved blood circulation and oxygen delivery, leading to a reduced metabolic rate [23]. Furthermore, this may diminish the danger of insulin resistance, a condition that might precipitate diabetes and other disorders linked to its progression [24]. Physical exercise affects the body's fat utilization, whereas decreased activity may result in localized fat buildup [24], [25]. Achieving appropriate energy equilibrium both internally and externally aids in weight control, increases physical attractiveness, improves muscle flexibility, and fortifies bone integrity. Participating in physical activity enhances self-confidence, vitality, physical strength, and overall energy levels.

Two-way relationship between physical activity and VO2max

The data analysis produced a p-value of 0.000 and a Pearson correlation coefficient of 0.884, signifying a robust positive link between physical activity and VO2max. This indicates a reciprocal link between the two variables [18] (Figure 2). The initial stage in enhancing fitness is participating in more intense physical exercise. The initial stage in enhancing fitness levels is participating in more intense physical exercise. Cardiorespiratory endurance, virtually synonymous with VO2max, is a crucial indication of physical fitness [26]. The degree of physical activity is directly associated with VO2max [27]. Physical activity stimulates muscle contractions that facilitate homeostasis in skeletal muscles by elevating the ATP/AMP ratio, augmenting Ca^{2+} influx into muscle cells, diminishing reactive oxygen species (ROS), lactate, and glycogen levels, and activating various protein kinases, notably adenosine monophosphate-activated protein kinase (AMPK), p38 Mitogen-Activated Protein Kinases (p38MAPK), and calcium/calmodulin-dependent protein kinase II (CaMKII) [28]. These kinases activate PGC-1α, the principal transcriptional coactivator implicated in mitochondrial biogenesis [29]. The International Physical Activity Questionnaire (IPAQ) serves to assess the correlation between physical activity and VO2max [18]. The IPAQ evaluates multiple aspects of physical activity, including aerobic exercise, which can improve fitness levels [9,27]. This work aligns with another experimental investigation by Setty et al. (2013), which soughts to determine the relationship between BMI and cardiorespiratory fitness in sixty men [30]. The study revealed that elevated obesity rates, poor cardiorespiratory fitness, and an inverse correlation between BMI and VO2Max underscore the imperative for regular aerobic exercise to enhance health outcomes [30].

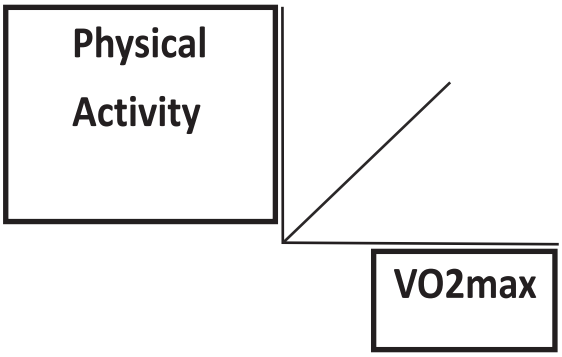

FIGURE 1. Correlation between physical activity and VO2max [18]

Two-way relationship between BMI and VO2max

The data analysis produced a p-value of 0.000 and a Pearson correlation coefficient of -0.896, signifying a robust negative association between BMI and VO2max. This indicates an inverse correlation, wherein an elevated BMI is linked to a diminished VO2max, and conversely, an increased VO2max is connected with a reduced BMI [18] (Figure 3). A high BMI adversely affects cardiorespiratory function and muscle oxygen uptake, as corroborated by additional research [26]. Obese individuals generally have reduced VO2max levels in comparison to non-obese persons [31]. This may result from an increase in type II muscle fibers and a decrease in type I muscle fibers in obese persons, causing diminished oxygen absorption [31]. Excess weight or obesity can adversely impact cardiovascular function, with elevated BMI associated with more significant decreases in function [32]. Chatterjee et al. (2006) discovered that BMI serves as a predictor of VO2max, suggesting that surplus adipose tissue in overweight and obese persons diminishes muscle oxygen usage, hence reducing VO2max [33,34]. This work aligns with another experimental investigation by Singh et al. (2023), which seeks to identify the decisive relationship between BMI and cardiorespiratory fitness [35]. The Singh study revealed that elevated obesity rates, poor cardiorespiratory fitness, and an inverse correlation between BMI and VO2Max underscore the imperative for regular aerobic exercise to enhance health outcomes [35]. Another study conducted by Hung et al. (2022) demonstrated a heightened risk of obesity—3.5 to 6.5 times greater—when VO2max falls below 45.5 mL/kg/min [36,37].

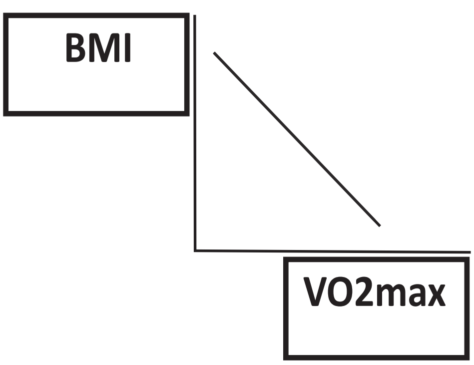

FIGURE 3. Correlation between BMI and VO2max [18]

CONCLUSION

The study demonstrated significant relationships among physical activity, BMI, and VO2max in overweight and obese men. Specifically, the result showed a strong negative relation between physical activity aand VO2max. Additionally, BMI and VO2max were inversely correlated. These findings indicate the necessity for more intense and focused interventions to improve the health outcomes, reducing BMI and improving cardiorespiratory fitness of men with excess weight.

This study elucidates significant relationships among physical activity, BMI, and VO2max; however, its limitations including sample size, dependence on self-reported data, and neglect of other critical variables underscore the necessity for additional research. Subsequent research should rectify these shortcomings by employing bigger, more heterogeneous samples, integrating objective assessments of physical activity, and accounting for a broader spectrum of health markers and confounding variables. Investigating many forms of physical activity, such as resistance training and flexibility exercises, would enhance the comprehension of how various exercise modalities influence BMI and VO2max. Furthermore, incorporating dietary evaluations with these methodologies would provide a more holistic understanding of the diverse factors influencing both BMI and overall health.

Authors' contributions
Original Researcher: Anang Fajar Aryanto, Damayanti Tinduh, I Putu Alit Pawana Putra
Methodologists: Anang Fajar Aryanto, Soenarnatalina Melaniani, Vitria Wuri Handayani
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Discussion: Anang Fajar Aryanto, Damayanti Tinduh, I Putu Alit Pawana Putra, Soenarnatalina Melaniani

Conflicts of interest:
We declare that we do not have any conflicts of interest.

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