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**Research Article**

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# Obesity and Correlation of Body Mass Index and Body Composition among Sports Sciences versus Non-Sport Sciences Students

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## Abstract

***Background***: Obesity contributes to the overall burden of disease worldwide. Adiposity can be measured using body mass index (BMI) and bioelectrical impedance analysis (BIA), such as body fat (BF) percentage. Physical education potentially controlled overweight (OW) and obesity (OB) among young adult students. ***Objective***: The study examined obesity and the correlation between body mass index (BMI) and body composition among students. ***Methods***: The study was a cross-sectional study using a non-athlete population of students aged 19-21 years (n=132) from sports sciences and non-sport sciences students. Body composition included body weight (BW) (kg), total body fat (BF), visceral fat (VF), and basal metabolic rate (BMR) (kcal) were evaluated. ***Results***: Non-sport sciences students have a higher prevalence of overweight (OV)/obese (OB) than sports sciences students. Among sports sciences students, BMI had a high positive correlation with BW and VF and a low positive correlation with BF. Among non-sport sciences students, BMI had a very high positive correlation with BW and a high positive correlation with BF and VF. ***Conclusions***: BMI was not an appropriately sensitive screening tool to find obesity in physically active individuals. Incorporation of physical education in course programs may control OV and OB among young adult students.

***Keywords***: Body composition, Correlation, Nutritional status, Obesity, Sports sciences students.

**السمنة وارتباط مؤشر كتلة الجسم وتكوين الجسم بين طلاب العلوم الرياضية وطلاب العلوم غير الرياضية**

**الخلاصة**

**الخلفية**: تساهم السمنة في العبء الكلي للمرض في جميع أنحاء العالم. يمكن قياس السمنة باستخدام مؤشر كتلة الجسم (BMI) وتحليل المعاوقة الكهربائية الحيوية (BIA)، مثل نسبة الدهون في الجسم (BF). يحتمل أن تتحكم التربية البدنية في زيادة الوزن (OW) والسمنة (OB) بين الطلاب البالغين الشباب. **الهدف**: فحصت الدراسة السمنة والعلاقة بين مؤشر كتلة الجسم (BMI) وتكوين الجسم لدى الطلاب. **الطرائق**: كانت الدراسة عبارة عن دراسة مقطعية باستخدام مجموعة من غير الرياضيين من الطلاب الذين تتراوح أعمارهم بين 19-21 عاما (العدد = 132) من طلاب العلوم الرياضية وغير الرياضية. تم تقييم تكوين الجسم من وزن الجسم (BW) (كجم)، والدهون الكلية في الجسم (BF)، والدهون الحشوية (VF)، ومعدل الأيض الأساسي (BMR) (السعرات الحرارية). **النتائج**: طلاب العلوم غير الرياضية لديهم انتشار أعلى لزيادة الوزن (OV) / السمنة (OB) من طلاب العلوم الرياضية. بين طلاب علوم الرياضة، كان لمؤشر كتلة الجسم ارتباط إيجابي مرتفع مع BW و VF وارتباط إيجابي منخفض مع BF. بين طلاب العلوم غير الرياضية، كان لمؤشر كتلة الجسم ارتباط إيجابي مرتفع جدا مع BW وارتباط إيجابي مرتفع مع BF و VF. **الأستنتاجات**: لم يكن مؤشر كتلة الجسم أداة فحص حساسة بشكل مناسب للعثور على السمنة لدى الأفراد النشطين بدنيا. قد يؤدي دمج التربية البدنية في برامج الدورة التدريبية إلى التحكم في OV و OB بين الطلاب البالغين الشباب.

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## INTRODUCTION

According to estimates by the World Health Organization (WHO), 650 million adults aged 18 and older were obese (OB) in 2016 [1], making up more than 1.9 billion adults who are overweight (OW). Worldwide, obesity prevalence has increased dramatically during the last four decades; it is predicted that in 2023, the world's adult population will be OW or OB [1]. Using data from the National Basic Health Survey 2017 in Indonesia, the prevalence of obesity among adults was 23.1%, which rates are higher among the female population [2]. Obesity contributes to the overall burden of disease worldwide [3]. It dramatically raises the risk of non-communicable diseases (NCDs), including cancer,

diabetes, coronary heart disease, and stroke [4]. Body mass index (BMI) and bioelectrical impedance analysis (BIA) are methods to measure adiposity. WHO recommends body mass index (BMI) as the most useful tool to measure OW and OB at the population level and is used in all ages of adults and the same for both sexes [5,6]. While BIA is used to measure body fat (BF) (%) [7]. The use of BIA in obesity diagnostic management is beneficial. This tool gives us better information on the location and distribution of fatty tissue [8]. The research on the correlation between BMI and body fat percentage (BF%) is numerous. However, the results are uncertain and vary across populations [9,10]. Several factors may influence this association, such as age, sex [9], ethnicity [11], obesity [8], and physical training (such as among the athletic population) [12]. Several studies showed the potential of physical education for helping to control overweight or obesity among children and adolescent students [13-16]. Our study was conducted among sports sciences students and non-sport sciences students. Sport sciences students have more physical education lessons in their curriculum compared to non-sport sciences students. In a systematic qualitative study targeting overweight and obese students, physical activity significantly reduces BMI [17]. A meta-analysis study shows that short-term moderate-intensity to high-intensity exercise training can result in modest improvements in OW and OB people's body composition without present changes in body weight [18]. Moreover, the current meta-analysis study showed the different types of sports combinations, in or out of school, especially when combined with non-sport activities, seem to bring greater benefits [19]. Hence, our study aimed to investigate the prevalence of obesity and the correlation between body composition and body mass index among non-athlete sport and non-sport sciences university students.

## METHODS

### *Population*

This study was a cross-sectional design using a population of university students aged 19-21 years (n=132). The study was conducted in June-July 2019 at Universitas Pendidikan Indonesia. All students who participated in the study gave written informed consent. We excluded athletes and students who have chronic disease or during the recovery period. The Medical and Health Research Ethics Committee, Faculty of Medicine, Public Health and Nursing, Dr. Sardjito General Hospital (number: KE/0930/08/2019) approved this study protocol. To calculate the number of subjects needed to be included in the study, the formula of the World Health Organization (WHO) sample size [20] was used with a 95% confidence level, anticipated population proportion 28.38% [21], and absolute precision required 0.1. The number of minimum subjects required was 78 students.

### *Outcome measurements*

Body composition included body weight (BW) (kg), BF (%), visceral fat (VF) (%), and basal metabolic rate (BMR) (kcal). Body compositions and BMR estimation were measured using BIA (Omron, HBF 375 Karada Scan). Height was measured using a stadiometer (SECA, 213-Portable-Stadiometer). BMI was calculated based on body weight and height using the formula weight (kg) divided by the square of body height ($m^2$).

### *Definitions*

Based on the Ministry of Health Republic of Indonesia, we defined nutritional statuses as underweight (UW) BMI<18,5, normal-weight (NW) BMI ≤18.5 to ≤25, overweight (OW) BMI >25 to ≥27, and obese (OB) BMI >27 [22].

### Statistical analysis

Data shows a comparison between sports and non-sport sciences students. Continuous variables were displayed as mean and standard deviation (SD), while categorical variables were displayed as percentages and numbers. When normality and homogeneity of variances were met, a chi-square test was used for categorical data and an independent t-test was used for continuous data to find the *p*-value. Pearson correlation was performed to test the correlation between BMI and body composition. Interpretation of correlation coefficient: negligible correlation if (*r*): 0.00 to 0.30 (-0.00 to -0.30), low positive (negative) correlation if (*r*): 0.30-0.50 (-0.30 to -0.50), moderate positive (negative) correlation if (*r*): 0.50 to 0.70 (-0.50 to -0.70), high positive (negative) correlation if (*r*): 0.70 to 0.90 (-0.70 to -0.90), very high positive (negative) correlation if (*r*): 0.90 to 1.00 (-0.90 to -1.00) [23]. We analyzed all data using SPSS. version 21 (IBM, Armonk, NY, USA). *p*-value <0.05 is considered a significant level.

## RESULTS

Table 1 presents the characteristics of students according to their major. Compared to sports sciences students, non-sport sciences students had a higher prevalence of female students (90.9% *vs*. 48.5%) and no exercise (56.1% *vs*. 28.9%). Compared to sport sciences students, non-sport sciences students have lower values of body composition parameters, including BW (kg) (54.2±10.1 *vs*. 57.8±9.7), height (cm) (156.3±6.2 *vs*. 161.4±9.0), and BMR (kcal) (1196±149 *vs*. 1345±216). In contrast, non-sport sciences students have a higher BF (%) compared to sport sciences students (27.3±5.9 *vs*. 20.9±6.3), all *p*-values <0.005. We categorized nutritional status into underweight, normal weight, and overweight/obese. Generally, the data shows that non-sport sciences students had a higher prevalence of overweight/obese compared to sports science. Moreover, sports sciences students had higher rates of normal-weight status

compared to non-sport sciences students (89.4% *vs*. 60.6%) (Figure 1). We next clarify the correlation between body mass index and body composition among sports and non-sport science students (Table 2). Pearson correlation showed that among sports sciences students, BMI had a high positive correlation with BW and VF (%), a moderate positive correlation with BMR, and a low positive correlation with BF (%). While among non-sport sciences students, there was a very high positive correlation between BW and BMI; a high positive correlation of BF (%), VF (%), and BMR with BMI was found, all $p<0.05$. We investigated the correlation according to gender. Among sports sciences students, the correlation for both males and females did not differ; BMI had a high positive correlation with BW and VF (%), a moderate positive correlation with BMR, and a low positive correlation with BF (%). Among male non-sports sciences students, BMI had a high positive correlation with BW and VF (%), a moderate positive correlation with BF (%), and BMR. While among female non-sport sciences students, a very high positive correlation between BW, a high positive correlation between BF (%), VF (%), and BMR, and BMI were found, all $p< 0.05$.

**Table 1**: Baseline characteristics of comparison between sport and non-sport sciences students

| Characteristics | Sport Science (n=66) | Non-sport Science (n=66) | *p*-value |
|---|---|---|---|
| General Characteristics | | | |
| Age (year) | 19±1.0 | 20±1.0 | 0.599 |
| Gender | | | |
| Male | 34 (51.5) | 6 (9.1) | <0.001 |
| Female | 32 (48.5) | 60 (90.9) | |
| Exercise | | | |
| Yes | 47 (71.2) | 29 (43.9) | 0.003 |
| No | 19 (28.8) | 37(56.1) | |
| Body composition | | | |
| BW (Kg) | 57.8±9.7 | 54.2±10.1 | 0.037 |
| Height (cm) | 161.4±9.0 | 156.3±6.2 | <0.001 |
| BF (%) | 20.9±6.3 | 27.3±5.9 | <0.001 |
| VF (%) | 4.33±2.49 | 4.30±5.71 | 0.074 |
| BMR (kcal) | 1345±216 | 1196±149 | <0.001 |
| BMI (kg/m$^2$) | 22.0±2.5 | 22.2±3.9 | 0.680 |

Values were expressed as frequency, percentage, and mean±SD. *p*-value was analysed by using chi-square for categorical parameters and independent t-test for continuous parameters. BW: body weight; BF: body fat; VF: visceral fat; BMR: basal metabolic rate; BMI: body mass index.

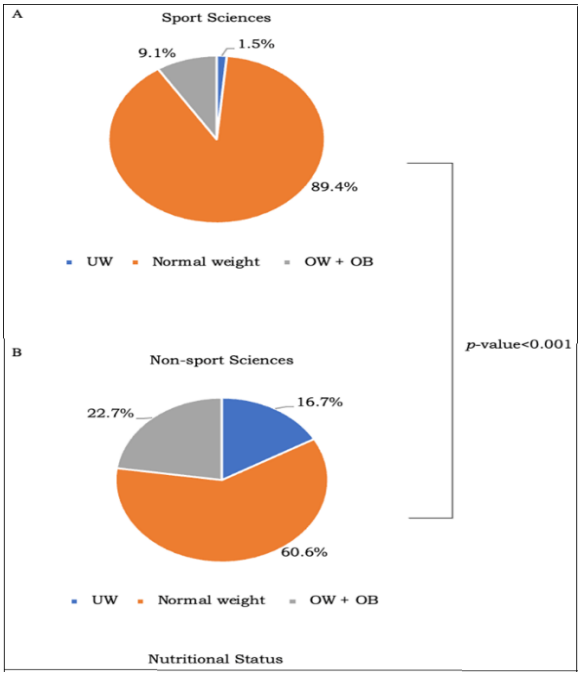


**Figure 1**: Nutritional status comparison between sport and non-sport science students. *p*-value was analysed by using *Chi-Square*. Abbreviation: UW, underweight; OW, overweight; OB, Obese.

## DISCUSSION

Our study investigated the potential of physical education for helping to control young adults' OW or OB. We found that OB prevalence was lower among sports sciences students than non-sport sciences students. Moreover, our study found that BF (%) of sports sciences students was lower than non-sport sciences students, even though the two groups have similar body mass index. BMI was highly positively correlated with BF (%) among non-sport sciences students. While, among sport sciences students, this association had a low positive correlation. In agreement with previous studies [13-16], physical education has great potential for helping to control overweight and obesity. We found sports sciences students have a higher prevalence of normal-weight students than non-sports sciences students. The intervention school study involving fourteen schools in Denmark revealed that taking three times as many physical education classes per week for five years successfully reduced BMI and the likelihood of continuing to be overweight or obese [14]. Qualitative studies among overweight or obese university students conducting a physical-activity-based intervention reported changes in BMI. Eleven of sixteen included studies showed a substantial decrease in BMI [17]. Moreover, the study among adult students from Relizane University (western Algeria) reported that the rate of obesity among students can be lowered by organizing educational and marketing initiatives to motivate students to participate in various physical activities [21]. Our findings provided evidence for the effective development and feasible physical education interventions targeting overweight and obese students. Our study found a high positive correlation between BMI and BF (%) among female non-sport sciences students ($r= 0.745$). Among male

non-sport sciences students, BMI has a moderate positive correlation with total fat ($r$= 0.537). Our study was in concordance with a cross-sectional study conducted among adults. The study revealed that BMI strongly correlated with BF (%) estimated by BIA in a subpopulation of South Asian adults [24]. A significant positive correlation was observed between BMI and BF% in males ($r$= 0.750) and females ($r$= 0.820) (24).

**Table 2:** Correlation between body composition and body mass index

| Body composition | BMI (kg/m$^2$) | | | |
|---|---|---|---|---|
| | Sport | | Non-sport | |
| | *r* | *p*-value | *r* | *p*-value |
| All students | | | | |
| BW (Kg) | 0.760 | <0.001 | 0.914 | <0.001 |
| Height (m) | 0.104 | 0.404 | -0.022 | 0.863 |
| BF (%) | 0.319 | <0.001 | 0.758 | <0.001 |
| VF (%) | 0.845 | <0.001 | 0.858 | <0.001 |
| BMR (kcal) | 0.544 | <0.001 | 0.805 | <0.001 |
| Male students | | | | |
| BW (Kg) | 0.771 | <0.001 | 0.822 | <0.001 |
| Height (m) | 0.050 | 0.675 | -0.006 | 0.953 |
| BF (%) | 0.379 | 0.001 | 0.537 | <0.001 |
| VF (%) | 0.813 | <0.001 | 0.826 | <0.001 |
| BMR (kcal) | 0.512 | <0.001 | 0.546 | <0.001 |
| Female students | | | | |
| BW (Kg) | 0.820 | <0.001 | 0.904 | <0.001 |
| Height (m) | 0.051 | 0.569 | -0.010 | 0.921 |
| BF (%) | 0.499 | <0.001 | 0.745 | <0.001 |
| VF (%) | 0.853 | <0.001 | 0.869 | <0.001 |
| BMR (kcal) | 0.584 | <0.001 | 0.797 | <0.001 |

Pearson correlation was used to detect association between BMI and body composition parameters. Abbreviation: BW, body weight; BF, body fat; VF, visceral fat; BMR, basal metabolic rate; BMI, body mass index

In contrast, a previous study tested among Chinese medical students found that compared to female students, male students had higher BF (%) and a higher BF (%) was significantly associated with worse physical fitness of medical students [25]. Moreover, male students require weight control because of their greater prevalence of OW and OB [25]. The present study showed that among sports sciences students, BMI had a low positive correlation with BF (%) ($r$= 319). A person's body composition is strongly connected to several functional aerobic capacities, such as their metabolic cost of work, heart volume, renal excretion of creatinine, oxygen consumption at rest, and more. Higher proportions of lean body mass are associated with better functional fitness. From a metabolic point of view, big changes in total body fat during times of changing physical activity intensity are linked to deeper changes in the metabolism of fat: adaptation for increased muscular work probably leads to an increased capacity to mobilize fat metabolites (and to use them more proportionally as a source of energy for work) and increased lipolytic activity in different tissues (e.g., heart muscle) [26]. On the other hand, decreased physical activity has the opposite effect. Among sport and non-sport sciences students, BMI had a high positive correlation with VF (%). Our study agrees with the study among medical students in Indonesia; BMI is strongly associated with VF [27]. BMI contributes to the prediction of VF among both populations but not to non-abdominal fat for sports sciences students. In agreement with the previous study, young people who major in physical education and physical culture are taller and heavier than the general population, regardless of gender [28]. A higher proportion of lean body mass composition was the reason for the higher body weight observed in students studying physical education [28]. We found that among sports science students there was a low correlation between total fat (%) and BMI. Since BMI is not a sensitive screening tool to identify fatness in young adults who are physically active, it should not be used for the measurement of fat content in body composition [28]. The present study has several limitations that need to be considered while interpreting the findings. The sample was taken from one of the public universities in Indonesia, so we cannot generalize these data to all Indonesians. However, our findings were comparable to those of other research that used controlled subject samples. Another limitation is that the cross-sectional study could not explain causality in the relation we found. BIA is not generally considered as a gold standard unlike the classic body composition technique (such as the water dilution technique or hydro densitometry). However, for simplicity, acceptability, and rapid data acquisition in the epidemiological study, some accuracy is sacrificed [29].

## Conclusion

Overweight and obesity prevalence was found more frequently among non-sport sciences students. In general, sports science students have a lower BF (%). BMI was not an unsuitably sensitive screening tool for adiposity detection among young adults who are physically active; therefore, it should not alternate for determining fat content in body composition. Hence, this study implies an important future study to investigate the sensitive measurement of adiposity among the athlete population. Physical education in course programs may control overweight and obesity among young adult students.

### Conflict of interests

No conflict of interest was declared by the authors.

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The authors did not receive any source of funds.

### Data sharing statement

Supplementary data can be shared with the corresponding author upon reasonable request.

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