Analysis of Energy Balance in Obese Healthcare Workers

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Abstract

Obesity is a global health challenge that seriously affects developing countries, including Indonesia. It is important to discover the energy balance calculated from energy intake and energy expenditure in obese individuals, especially in obese healthcare workers. This study aimed to analyze the balance of energy intake and expenditure, body composition, and physical activity level in obese healthcare workers at the Exercise Center of Indonesia Medical Education and Research Institute (IMERI FKUI). A cross-sectional study was held at Exercise Center IMERI FKUI. Total sampling was the sampling method utilized in the study. Study participants (aged above 18 years) were screened by measuring body composition, and obesity status was determined based on BMI data (≥25 kg/m²). The selected subjects were then administered for data collection on body composition using the multi-frequency bioelectrical impedance analysis (MF-BIA) instrument, energy intake using the MyFitnessPal (MFP) application, as well as energy expenditure and physical activity level using the IPAQ-SF tool. From a total of 12 obese healthcare workers at the Exercise Center, 11 (91.67%) participants had a negative energy balance, and 1 (8.33%) participant had a positive energy balance during a 7-day period of data collection. In addition, the average body composition components and physical activity levels vary between men and women participants. Overall, a majority of the obese healthcare workers at the Exercise Center reported a negative energy balance.

Keywords: body composition, energy balance, obesity, physical activity

Abstrak

Obesitas merupakan salah satu masalah kesehatan global yang menimpa negara berkembang, termasuk Indonesia, secara serius. Keseimbangan energi yang dilihat dari asupan energi dan pengeluaran energi pada individu dengan obesitas menjadi penting untuk diketahui, terutama pada tenaga kesehatan. Penelitian ini bertujuan untuk menganalisis keseimbangan asupan dan pengeluaran energi, komposisi tubuh, dan tingkat aktivitas fisik pada tenaga kesehatan dengan obesitas di Exercise Center Indonesia Medical Education and Research Institute (IMERI FKUI). Penelitian ini menggunakan desain potong lintang. Total sampling adalah metode pengambilan sampel yang digunakan. Skrining untuk status obesitas subjek (berumur lebih dari 18 tahun) ditentukan berdasarkan data IMT (≥25 kg/m²) yang didapatkan dari pengukuran komposisi tubuh. Subjek yang terpilih diambil data komposisi tubuh menggunakan alat multi-frequency bioelectrical impedance analysis (MF-BIA), asupan energi menggunakan aplikasi MyFitnessPal (MFP), serta pengeluaran energi dan tingkat aktivitas fisik menggunakan kuesioner IPAQ-SF. Ditemukan adanya 11 (91.67%) individu yang memiliki keseimbangan energi negatif dan ada 1 (8.33%) individu yang memiliki keseimbangan energi positif dari total 12 tenaga kesehatan dengan obesitas di Exercise Center selama periode 7 hari pengambilan data. Selain itu, rata-rata dari komponen komposisi tubuh dan tingkat aktivitas fisik bervariasi antara subjek laki-laki dan perempuan. Secara keseluruhan, sebagian besar dari tenaga kesehatan dengan obesitas di Exercise Center melaporkan keseimbangan energi negatif.
Kata kunci: komposisi tubuh, keseimbangan energi, obesitas, aktivitas fisik
Introduction

Obesity is a global health challenge that seriously affects developing countries (1, 2). Indonesia as a developing country is still faced with obesity as one of the main health problems. The prevalence of obesity in Indonesia has increased 1.5-2 times since 1993 (3). The increase in the prevalence of obesity in adults aged above 18 years in Indonesia can be seen based on data from the National Health Survey of the Republic of Indonesia, namely 8.6% (2007), 11.5% (2013), and 13.6% (2018) (4).

For adults, the World Health Organization (WHO) describes overweight with a body mass index (BMI) of $\geq 25$ kg/m$^2$ and obesity with a BMI of $\geq 30$ kg/m$^2$ (5). According to the Asia-Pacific category, BMI can be categorized into four groups, namely underweight ($<18.5$ kg/m$^2$), normal weight ($18.5-22.9$ kg/m$^2$), overweight ($23-24.9$ kg/m$^2$), and obese ($\geq 25$ kg/m$^2$) (6). Based on data from the National Health Survey of the Republic of Indonesia in 2018, the prevalence of adults aged above 18 years with overweight (BMI of $\geq 25$ to $<27$ kg/m$^2$) and obesity (BMI $\geq 27$ kg/m$^2$) in DKI Jakarta province was 15.6% and 29.8% (7). DKI Jakarta province has been reported as one of the five provinces with the highest general prevalence of obesity in Indonesia, besides East Kalimantan, North Sulawesi, North Maluku, and Gorontalo (8).

Factors that determine the occurrence of obesity are very complex (9). Lifestyle, food intake, physical activity, genetic factors, environmental characteristics, socioeconomic status, urbanization, and food security are the determinants of obesity in developed and developing countries (8). Other factors such as age, gender, psychological/stress factors, smoking behavior, alcohol consumption, and nervous system disorders are also described as determinants of obesity (4, 8). In addition to the various factors that can lead to obesity, energy balance, and lifestyle play a very important role (10).

One of the main aspects of lifestyle is energy intake from food and drink. Obesity is generally considered a distortion of energy balance (11). A positive energy balance occurs when an individual consumes more energy than is expended in activities (8). This excess of energy leads to excess fat accumulation and weight gain (11, 12). Therefore, the basic view of obesity treatment is control over energy balance by reducing energy intake (EI) and increasing energy expenditure (EE).

Another important aspect of daily life is physical activity (13). A lot of literature revealed that physically active people possess a lower risk of gaining weight and being overweight as well as obese (8, 10, 14). A number of recent studies have shown that behaviors in daily life such as increased sedentary behavior, decreased physical activity, and reduced sleep time lead to excessive food consumption (10). As is commonly stated, swapping sedentary behavior for physical activity of varying intensity can have health benefits. WHO recommends that adults aged 18-64 years do at least 150-300 minutes of moderate-intensity aerobic physical activity per week or at least 75-150 minutes of vigorous-intensity aerobic physical activity per week (14).

In 2020, 33.5% of the Indonesian population had low physical activity, an increase compared to 2013 with a proportion of only 26.1% (9). Several factors that can affect physical activity in Indonesia are economic development, rapid urbanization, and technological advances, especially in the field of transportation which can create an environment for sedentary behavior and
Various efforts in the health sector to reduce overweight and obesity in adults have focused on treatment through weight loss. The desired target for obese individuals is weight reduction through decreasing fat mass concurrently with maintaining or increasing fat-free mass. This is because fat-free mass is a major determinant of basal energy expenditure, maintenance of metabolism, and overall health (11). However, it is also necessary to consider effective approaches to preventing excess weight gain to reduce the prevalence of overweight and obesity, such as increased physical activity (10). To avoid the detrimental effects of sedentary behavior on health, all adults and the elderly are encouraged to try to do more physical activity than the level recommended by WHO (14).

Obesity among healthcare workers (e.g., doctors) is a significant problem because it can affect their state of health and their professional ability and/or credibility in advising patients, particularly regarding lifestyle modifications (16). This study aims to analyze energy balance (energy intake and energy expenditure), body composition, and physical activity level in obese healthcare workers at Exercise Center IMERI FKUI. Most of the personnel at the Exercise Center are academics of the University of Indonesia (doctors, residents, medical students, educational staff, and employees) with limited physical activity (or sedentary behavior) as a result of the demands of daily occupational duration.

Methods

This study was a descriptive study using a cross-sectional design. This study was conducted at the academics of the University of Indonesia (i.e., healthcare workers) with a BMI of ≥ 25 kg/m² who were enrolled at Exercise Center IMERI FKUI during one month of the study period from October to November 2022 (inclusion criteria). Service in the Exercise Center is provided and supervised by Sports Medicine Specialists through physical exercise programs, limited to 19 personnel during the study period. Total sampling was the sampling method utilized in the study, where participants’ eligibility screening was determined based on BMI data (≥ 25 kg/m²) obtained from body composition measurements using the MF-BIA instrument. From the screening based on the inclusion criteria, 12 study participants were included in the study. The data collection procedure was conducted for 7 consecutive days. Data collection on body weight, body height, BMI, BMR, body fat mass, body fat percentage, and body muscle mass was also carried out by measuring body composition using the MF-BIA instrument on day one. Energy intake data were collected by reporting food and beverage calorie data entered by participants into the MyFitnessPal (MFP) application from day one to day seven. Data collection on physical activity level and energy expenditure was carried out by filling out the Bahasa Indonesia version of the IPAQ-SF (International Physical Activity Questionnaire Short-Form) on day seven. The factorial estimate of total daily energy expenditure (TDEE) is calculated from the sum of data on the components of energy expenditure, namely basal metabolic rate (BMR), thermic effect of food (TEF), non-exercise activity thermogenesis (NEAT), and exercise activity thermogenesis (EAT). Analysis of the data was processed using the Microsoft Excel 2021 computer program.
Results

A total of 12 adult participants aged above 18 years old, namely 8 men (67%) and 4 women (33%) with a BMI of $\geq 25$ kg/m$^2$ (indicating obesity), took part in this study. The basic characteristics data of participants in this study (i.e., gender and age distribution) are presented in Figure 1 and Figure 2. The average body composition data of participants in this study are presented in Table 1 below.

The daily average energy intake data of participants in this study is presented in Figure 3. Out of a total of 8 men, the mean energy intake reported was $1993.52 \pm 310.15$ kcal/day, while out of a total of 4 women, the mean energy intake reported was $1191.39 \pm 210.55$ kcal/day.

The physical activity level data of participants in this study is presented in Figure 4. It was found that 1 (8.33%) man had a low physical activity level, 2 (16.67%) women and 4 (33.33%) men had a moderate physical activity level, and 2 (16.67%) women and 3 (25%) men had a high physical activity level during the 7-day period of data collection.

Figure 1. Distribution of participants’ gender

Figure 2. Distribution of participants’ age
Table 1. Distribution of participants’ average body composition components

<table>
<thead>
<tr>
<th>Gender</th>
<th>n</th>
<th>Body weight (kg)</th>
<th>Body height (m)</th>
<th>BMI (kg/m²)</th>
<th>Body fat mass (kg)</th>
<th>Body fat percentage (%)</th>
<th>Body muscle mass (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>8</td>
<td>85.43±8.58</td>
<td>1.67±0.04</td>
<td>30.78±2.8</td>
<td>25.16±6.92</td>
<td>29.03±5.71</td>
<td>57.15 ± 3.19</td>
</tr>
<tr>
<td>Female</td>
<td>4</td>
<td>63.68±4.64</td>
<td>1.55±0.07</td>
<td>26.53±0.82</td>
<td>24.08±1.56</td>
<td>37.8±1.16</td>
<td>37.28 ± 2.97</td>
</tr>
</tbody>
</table>

Data is presented in mean ± standard deviation (SD)

Figure 3. Distribution of participants’ average energy intake (EI) and energy expenditure (EE)

<table>
<thead>
<tr>
<th>Gender</th>
<th>EI</th>
<th>EE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>1993.52</td>
<td>2320.54</td>
</tr>
<tr>
<td>Female</td>
<td>1191.39</td>
<td>1863.46</td>
</tr>
</tbody>
</table>

Figure 4. Distribution of participants’ physical activity level
Discussion

There were 12 healthcare workers with BMI $\geq 25$ kg/m$^2$ who participated in this study, namely 8 men and 4 women (Figure 1). The findings of this study indicate that the proportion of obesity is higher in late adult participants (40-59 years) as many as 8 (66.67%) individuals compared to early adult participants (20-39 years) as many as 4 (33.33%) individuals, and this is in line with the findings from previous studies which revealed that obesity and central obesity tend to increase with age—particularly since body fat accumulates naturally during middle adulthood—until a reduction occurs during older adulthood (aged $\geq 65$ years) (17-19).

Obesity is generally more common in women than men (1, 20, 21). Women have a higher risk of obesity compared to men even though they eat refined carbohydrates or fatty fried foods with the same amount and frequency (22). This is due to differences in hormone regulation that regulate energy intake and energy expenditure between men and women, for instance, the interaction between estrogen, leptin, and thyroid hormone in women (23). Another reason is that women's energy expenditure is lower than that of men, so this causes overall fat storage to tend to be higher in women (24). However, gender differences regarding the association between eating habits and obesity have been reported inconsistently in several studies. This is because there are various types of factors involved, such as environment, metabolism, lifestyle, genetics, hormone performance, behavior, and culture in determining a person's weight and body composition (22, 25-27).

Men and women have differences in the proportion of body fat, the pattern of fat accumulation, mobilization and utilization of body fat as metabolic fuel, as well as the consequences of excess and deficiency of fat storage in the body (27). This difference stems from differences in metabolism and hormones between men and women at birth, thus providing differences in the health risks that cause obesity between men and women.

The average BMI of obese men and women at the Exercise Center were 30.78 kg/m$^2$ and 26.53 kg/m$^2$, respectively (Table 1). According to the Asia-Pacific category, a BMI of $\geq 25$ kg/m$^2$ is categorized as obesity. With respect to BMI correction, women have larger stores of adipose tissue than men, and this applies to all races and cultures (27). Previous studies have shown that obesity is more common in women than men, although obesity is a heterogeneous condition (20). This is in line with the findings of this study which showed body fat mass and body fat percentage data amounting to 24.08 kg (37.8%) for women and 25.16 kg (29.03%) for men relative to an average body weight of 63.68 kg for women and 85.43 kg for men.

The findings of this study also show that the average muscle mass of obese healthcare workers at the Exercise Center is 57.15 kg for men and 37.28 kg for women. It was found that there were 11 (91.67%) obese healthcare workers with less muscle mass, based on the adequate muscle mass range criteria available from the MF-BIA instrument. The age-related loss of muscle mass and strength or physical performance is called sarcopenia. Sarcopenia is often accompanied by an increase in the amount of adipose tissue, and this condition is called sarcopenic obesity (28). The etiology of age-related physiological changes in body composition is so far complex and poorly understood. However, lifestyle, metabolic disorders, and negative
hormonal changes are indeed factors associated with sarcopenia. Sarcopenia and obesity share many similar pathological mechanisms, including insulin resistance and chronic, low-grade inflammation. In this case, excess fat mass can indeed cause inflammation that contributes to the development of sarcopenia.

The main results of this study revealed that there were 11 (91.67%) who had a negative energy balance and there was 1 (8.33%) participant who had a positive energy balance at the Exercise Center during the 7-day period of data collection (based on the comparison between participants’ EI and EE in Figure 3). These results are different when compared to the general picture of obesity, namely the amount of energy intake is greater than energy expenditure. Energy expenditure which is greater than energy intake in this study is largely due to the limitations of the results obtained, in the form of an estimate from the TDEE factorial estimation method. In this case, self-reporting for the amount of energy intake (using MFP) and energy expenditure (using IPAQ-SF) by obese participants certainly affects the accuracy of the results obtained.

One of the main features of the MFP application is the ability to record food intake. In this study, the MFP application was utilized due to being a feasible and applicable method to implement in regard to the short study period. The application offers a diverse food database, and the absence of a country-specific food composition database can be a barrier in measuring energy and nutrient intake. Another study reported that estimates of the calorie content of food and beverages on the MFP were considered inaccurate, with a tendency to reduce calorie content, differences in data estimates for the same food item, and mismatch of information on food and beverage packaging with the data stated on the application. This inaccuracy appears to occur because anyone can enter calorie data for a food or drink item in the MFP public database.

One of the main things to consider when using the MFP is when to record food intake. In this study, no specific time was specified for recording food intake, thus users can decide to enter data before, during, or after eating and drinking even though they know that the best time to record food is when it is consumed. MFP users are divided into two categories, namely users who are not very motivated to record their food and do not record everything consumed (not committed), and users who are motivated to record what is consumed (committed). Logging food for calorie estimation can be very time consuming in the midst of an individual’s sometimes very busy schedule. Thus, often study participants recorded meals during breaks at work or at the end of the day, after work and dinner, when more free time was available. In addition, excess calories can also be manipulated out of existence by not entering data into MFP. This could be one of the underlying factors why the reported calorie intake is much lower than that included in this study. Calculation of the number of calories included in the use of MFP in this study was also not validated and could tend to induce underestimation or overestimation.

In this study, obese participants at the Exercise Center also reported their physical activity level for 7 consecutive days through IPAQ-SF. The result was 1 (8.33%) man with low physical activity level, 4 (33.33%) men and 2 (16.67%) women with moderate physical activity level, as well as 3 (25%) men and 2 (16.67%) women with high physical activity level (Figure 4). These results are different when compared to the general description of obesity, namely,
lack of physical activity as one of the most important risk factors for obesity. The difference in the results of this study may have occurred because obesity is described as a condition that occurs due to low physical activity and excess energy intake in the long term, while physical activity data collection in this study only lasted for 7 days (8, 39).

The difference in results found in this study may also be due to the lack of accuracy of the IPAQ-SF questionnaire for estimating physical activity level and energy expenditure reported by participants (i.e., self-reporting method which may give rise to bias due to largely depending on the enthusiasm, adherence, and memory of the participants). Previous studies suggest that most validation studies only have a small correlation with the objective measures of activity achieved (40). In addition, the IPAQ-SF tends to overstate reported amounts of physical activity compared to objective devices—where physical activity was overreported and sitting time was underreported (41, 42). The IPAQ-SF is advised to be used with caution, as is the interpretation of the results in both relative and absolute terms (40, 42).

As another predominant limitation in this study, there is a possibility that the participants may have altered their lifestyle practices, presumably due to the knowledge of being in an obese condition and/or of being observed although these changes cannot be observed (i.e., due to the cross-sectional study design)—and thus may tend to induce underestimation or overestimation. Furthermore, although the researchers involved in this study managed to collect the overall data (e.g., energy intake, energy expenditure, body composition, and physical activity level) from a total of 12 obese healthcare workers, the relatively small sample size and a short period of study remains a limitation.

**Conclusion**

This study concludes several key takeaways regarding the description of energy balance, body composition, and physical activity level of obese healthcare workers at Exercise Center IMERI FKUI. It was found that a majority of obese healthcare workers reported a negative energy balance. The average body weight, height, BMI, fat mass, fat percentage, and muscle mass data vary among men and women participants. Lastly, a majority of participants reported a moderate to high physical activity level.

Suggestions that can be given to obese healthcare workers include the urgency of improving the quality of diet by reducing the amount of calorie intake and increasing physical exercise with the main target of reducing body fat mass and increasing body muscle mass. A suggestion that can be given to healthcare supervisors—especially Sports Medicine Specialists—includes providing education and more attention to fellow healthcare workers with obesity to improve body composition as the muscle strength training program progresses as well as guidelines for using MFP regarding weight management.

**Acknowledgment**

This study has received ethical approval with the number KET-1111/UN2.F1/ETIK/PPM.00.02/2022 from the Ethics Committee of the Faculty of Medicine, University of Indonesia – National Central General Hospital dr. Cipto Mangunkusumo (KEPK FKUI–RSCM). The selected subjects were given informed consent prior to participating in this study.
List of Abbreviations

Basal Metabolic Rate (BMR), Body Mass Index (BMI), Energy Expenditure (EE), Energy Intake (EI), Exercise Activity Thermogenesis (EAT), International Physical Activity Questionnaire-Short Form (IPAQ-SF), Multi-Frequency Bioelectrical Impedance Analysis (MF-BIA), MyFitnessPal (MFP), Non-Exercise Activity Thermogenesis (NEAT), Total Daily Energy Expenditure (TDEE), Thermic Effect of Food (TEF), World Health Organization (WHO).

References


