The associations of healthy eating index, sedentary lifestyle, and sleep quality with obesity in middle-aged and older adults in Semarang

Hubungan healthy eating index, sedentary lifestyle, dan kualitas tidur dengan obesitas pada usia paruh baya dan lanjut usia di Semarang

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Abstract

The prevalence of obesity in Indonesia among adults in 2007 – 2023 has continued to increase from 10,5% to 23,4%. The causes of obesity are multifactorial, but those that have an essential role are diet and lifestyle. Weight gain is associated with unhealthy food intake, a lack of physical activity, and poor sleep quality. This study aimed to analyze the associations of AHEI (Alternative Healthy Eating Index), sedentary lifestyle, and sleep quality with the incidence of obesity. This research used a cross-sectional study among subjects aged more than or equal to 40 years, involving 153 subjects in Semarang in February 2024 and using purposive sampling. AHEI data were collected through an interview process using the SQ-FFQ in days to years, sedentary lifestyle using the SBQ in a week, and sleep quality using the PSQI in a month. Fisher's exact and chi-square tests were used for bivariate analysis, whereas logistic regression was used for multivariate analysis. The results showed that a sedentary lifestyle on weekdays and weekends was associated with the incidence of obesity (p=0,000; OR=8,014) and (p=0,000; OR=18,516, respectively). In conclusion, a sedentary lifestyle is associated with incidence of obesity, while AHEI and sleep quality are not associated with incidence of obesity.

Keywords: AHEI, obesity, sedentary lifestyle, sleep quality

Abstrak

Prevalensi obesitas di Indonesia pada orang dewasa di tahun 2007 – 2023 terus mengalami peningkatan yaitu dari 10,5% meningkat menjadi 23,4%. Penyebab obesitas bersifat multifaktoral, namun penyebab obesitas yang memiliki peran penting adalah pola makan dan gaya hidup. Peningkatan berat badan berhubungan dengan asupan makanan yang tidak sehat, kurangnya aktivitas fisik, dan kualitas tidur yang buruk. Tujuan penelitian ini yaitu untuk menganalisis hubungan antara AHEI (*Alternative Healthy Eating Index*), *sedentary lifestyle*, dan kualitas tidur dengan kejadian obesitas. Penelitian ini menggunakan studi *cross-sectional* pada subjek yang berusia lebih dari atau sama dengan 40 tahun, yang melibatkan 153 subjek di Semarang pada bulan Februari 2024 dan menggunakan purposive sampling. Data AHEI diambil melalui proses wawancara menggunakan SQ-FFQ dalam hitungan hari hingga tahun, *sedentary lifestyle* menggunakan SBQ dalam hitungan minggu, dan kualitas tidur menggunakan PSQI dalam hitungan bulan. Uji *Fisher's Exact* dan *Chi-Square* digunakan untuk analisis bivariat, sedangkan regresi logistik digunakan untuk analisis multivariat. Hasil menunjukkan bahwa antara *sedentary lifestyle* pada hari kerja dan hari libur terdapat hubungan dengan kejadian obesitas dengan (p=0,000; OR=8,014) dan (p=0,000; OR=18,516). Kesimpulan, *sedentary lifestyle* pada hari kerja dan hari libur berhubungan dengan kejadian obesitas, sedangkan AHEI dan kualitas tidur tidak berhubungan dengan kejadian obesitas.

Kata Kunci: AHEI, kualitas tidur, obesitas, *sedentary lifestyle*

Introduction

The prevalence of obesity is growing worldwide, with nearly one-third of the world's population classified as obese (Chooi et al., 2019). According to the results of the Basic Health Research Data, the prevalence of obesity in Indonesia among adults over 18 years of age in 2007–2023 will continue to increase from 10,5% to 23,4%. Obesity in Central Java Province is approximately 20,4%, which is close to the national prevalence (Kementerian Kesehatan RI, 2023). According to Semarang City Health Office data for 2023, the highest number of obesity cases in Semarang City were Pegandan (6.218 cases), Purwoyoso (6.218 cases), and Bulu Lor (5.566 cases) (Dinas Kesehatan Kota Semarang, 2023).

Obesity is a complex chronic disorder with many contributing factors that play a vital role in increasing the incidence of degenerative diseases worldwide (Wang et al., 2021). Obesity occurs when the body stores more energy than it uses, causing excess energy to be stored in fat cells, thus developing the pathological characteristics of obesity. The causes of obesity are multifactorial, but the causes that have an essential role are diet and lifestyle (WHO, 2021). Weight gain is associated with unhealthy food intake and a lack of physical activity (Kutty & Zhi, 2015; Peltzer et al. 2014; Peltzer & Pengpid 2017; Williams et al. 2015). Additionally, longer and shorter sleep durations are associated with a greater risk of obesity (Suliga et al., 2017).

Diet can be analyzed in terms of its quality and quantity (Maya et al., 2023). Diet quality measurement involves assessing the consumption of food or food groups as an index (Xu et al., 2020). One of the food consumption quality assessment instruments that can be used is the Alternative Healthy Eating Index (AHEI) developed by the American Guidelines (Mosher et al., 2016). The AHEI is a modified Indonesian version with portions adjusted to the Indonesian diet based on the Balanced Nutrition Guidelines 2014 and Indonesian Food Composition Table (Briawan et al., 2020). Higher food consumption quality scores generally reflect healthier and optimal consumption quality or closer adherence to dietary recommendations (Thorpe et al., 2014).

Behavioral changes in society include increased physical inactivity and declining physical fitness levels. Lifestyle changes, such as lack of activity, contribute to an increase in obesity (Guthold et al., 2018). This is particularly true for elderly individuals with low physical activity levels. High levels of physical activity are associated with lower risks of obesity, diabetes, and coronary heart disease (Cleven et al., 2020). Therefore, it is important to reduce sedentary time in the elderly. Other factors such as sleep deprivation have been identified to contribute to weight gain through their effects on hormones, fatigue, and daytime sleepiness (Beebe et al., 2013). Both adults and the elderly often experience sleep disorders. However, it is most common in the elderly because of regular changes (Direktorat Jenderal Pelayanan Kesehatan Kemenkes, 2023).

Health behaviors often interact and increase the likelihood of multiplicative diseases in humans, such as lifestyle behaviors related to obesity, which has prompted the interest of researchers to conduct research on lifestyles related to obesity by examining the quality of food consumption, sedentary lifestyle, and sleep quality, especially in middle-aged and elderly individuals, because middle-aged and older age groups have a higher risk of developing obesity (Nomani, 2021). Age is a period closely related to food consumption and lifestyles that need to be regulated and improved due to several factors such as physiological changes, limited mobility, and health problems. The city of Semarang, which is one of the major cities with a growing population, often faces specific health challenges related to modern lifestyles as well as several areas that have a high number of obesity cases

Methods

This was an observational cross-sectional study. This study was conducted in the working area of the Pegandan Health Center and Bulu Lor Health Center, Semarang City, which was selected based on the high prevalence of obesity, and was conducted in February 2024.

The population in this study included all visitors to the Pegandan and Bulu Lor health centers. The sample used in this study consisted of 153 participants. Participants. Sampling was performed using a purposive sampling technique, where the sample was

selected based on inclusion criteria, such as age ≥ 40 years, visiting the Pegandan Health Center and Bulu Lor Health Center, and being able to communicate actively. At the same time, the exclusion criteria were pregnancy, breastfeeding, and complications such as heart disease, autoimmune diseases, and diabetes mellitus.

$$n = \frac{z^2 1 - a/2\,p(1 - P)}{d^2}$$

Description:
n : Sample size required
z 1-a/2 : 95% significance level
p : Proportion of variables based on existing facts
d : Precision to be achieved (decimal)

Food consumption quality data were obtained from the Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ) adapted from Syauqy et al. (2021), assisted by a food photo book and Nutri Survey software, and then processed using the Alternative Healthy Eating Index. The score of each component was summed so that the total score of the AHEI was known. The Alternative Healthy Eating Index (AHEI) score category is divided into two categories, namely good if the AHEI score is ≥80 and needs improvement if the AHEI score is <80. Sedentary lifestyle data were obtained from the Sedentary Behavior Questionnaire (SBQ), which was divided into weekdays and weekends. The final score was obtained from the sum of all sedentary activity times (hours) from respondents with a score of >6 hours including high, and ≤6 hours including low. Sleep quality was assessed by using the Pittsburgh Sleep Quality Index (PSQI). The PSQI measures sleep quality over a 1-month interval and consists of 19 questions that measure seven assessment components. A score ≤ 5 is good and > 5 is bad. The incidence of obesity, muscle mass, and body fat mass was measured using bioelectrical impedance analysis (BIA).

The univariate analysis summarized the descriptive frequencies for each variable presented in the tables and narratives. Fisher's exact, Chi-square, and Independent T-tests were used for bivariate analysis, logistic regression was used for multivariate analysis, and the logistic regression test was divided into two

models, adjusted for confounding variables and not adjusted.

The Faculty of Medicine's Health Research Ethics Commission at Diponegoro University granted ethical clearance for this study under the reference number 057/EC/KEPK/FK-UNDIP/II/2024.

Result and Discussion

The characteristics of the respondents in this study were sex, education level, occupation, body fat percentage, and muscle mass. Table 1 presents the characteristics of 153 respondents. The Chi-square test results showed no significant association between sex and the incidence of obesity. The respondents' educational level was dominated by a low level of education (49,7%). The level of education is related to the ability to absorb and receive health information and contribute to health development (Afifah et al., 2022).

There are 76 people were classified as obese or not working. This is related to physical activity, which involves energy expenditure. The energy use varies depending on the type of activity. Some activities require high energy expenditures, whereas others require less energy. Work is a behavioral factor associated with energy balance (Brown and Pavey, 2016). Based on the chi-square test, there was an association between occupation and incidence of obesity. A total of 104 people (68%) had high body fat mass, and the average obese respondent had high body fat mass. Chi-square test showed an association between body fat mass and the incidence of obesity.

Most respondents had low muscle mass, namely 105 people (68,6%); 60 people (39,2%) who were obese had low muscle mass. Muscle mass plays an important role in physical performance in older adults. Age-related loss of muscle mass is known as sarcopenia. Sarcopenia can lead to decreased physical function (Van Dongen et al. 2017). Decreased muscle strength can impair the functional abilities of older adults because it plays a role in almost all daily activities, increasing their dependence on activities and assistance from others (Azab et al., 2015). People who are classified as obese experience a decrease in muscle strength that is tasked with supporting body weight compared to those who are not obese (Tomlinson et al.,

2016). Owing to various mechanisms, the aging process reduces muscle mass in old age. Aging is associated with functional and structural changes at the neuromuscular level such as impaired neuromuscular activation and loss of muscle mass (Valenzuela et al., 2019).

Table 1. Characteristics of respondents

Characteristics	Obese (n=80)		Non-obese (n=73)		Total		p-value
	n	%	n	%	n	%	
Gender							
Male	12	7,9	17	11,1	29	19,0	0,191
Female	68	44,4	56	36,6	124	81,0	
Education Level							
Low	50	32,7	26	17	76	49,7	0,003
Moderate	24	15,7	40	26,1	64	41,8	
High	6	3,9	7	4,6	13	8,5	
Occupation							
Employed	4	2,6	18	11,8	22	14,4	0,001
Unemployed	76	49,7	55	35,9	131	85,6	
Body fat mass							
Normal	0	0	14	9,2	14	9,2	0,000
High	70	45,8	34	22,2	104	68,0	
Very high	10	6,5	25	16,3	35	22,9	
Muscle mass							
Normal	7	4,6	24	15,7	31	20,3	0,000
Low	60	39,2	45	29,4	105	68,6	
High	13	8,5	4	2,6	17	11,1	

Table 2. The associaton between AHEI, sedentary lifestyle on weekday and weekend, and sleep quality with incidence of obesity

Variable	Obese (n=80)			Non-obese (n=73)			p^1	p^2
	n	%	Mean ± SD	n	%	Mean ± SD		
AHEI			63,8±7,33			64,9±8,18	0,407	
Good (≥80)	1	1		4	5,5			0,193
Need Improvement (<80)	79	99		69	94,5			
Sedentary Lifestyle								
Weekday			7,58±1,41			4,81±2,07	0,000	
Low (≤ 6 jam)	11	13,7		58	79,5			0,000
High (> 6 jam)	69	86,3		15	20,5			
Weekend			8,25±1,82			4,58±2,71	0,000	
Low (≤ 6 jam)	8	10		57	78,1			0,000
High (> 6 jam)	72	90		16	21,9			
Sleep Quality			6,21±2,68			5,82±2,71	0,373	
Good (≤5)	34	42,5		36	49,3			0,398
Poor (>5)	46	57,5		37	50,7			

*p^1 = t-test, p^2 = Fisher's exact test, and chi-square test, significant (p<0,05).

Table 2 presents the association of AHEI, sedentary lifestyle on weekdays and weekends, and sleep quality, with the incidence of obesity. Among respondents who were classified as obese, the majority had the quality of food consumption based on AHEI, which is classified as needing improvement (99%), as well as among respondents who were not obese, the majority had the quality of food consumption, which was classified as needing improvement (94,5%). The result of the association test using Fisher's exact test between AHEI and the incidence of obesity has a p-value of 0,193, which means that there is no association between AHEI and the incidence of obesity among middle-aged and older adults. This is

similar to Table 3, which shows no association after adjusting for the confounding variables. This result is in line with that of Varkaneh et al. (2018), who stated that abdominal obesity may decrease if the AHEI score increases. However, there was no association between AHEI score and general obesity among the elderly (Varkaneh et al., 2018).

Table 3. Multivariate Analysis

Variable	Model 1[a]			Model 2[b]		
	OR	95% CI	p	OR	95 % CI	p
Alternative Healthy Eating Index Good						
Need Improvement	12,75	1,060 – 153,21	0,045	19,49	0,917 – 414,23	0,057
Sedentary Lifestyle Weekday Low						
High	6,92	2,301 – 20,774	0,001	8,01	1,896 – 33,871	0,005
Sedentary Lifestyle Weekend Low						
High	12,26	3,888 – 38,681	0,000	18,52	3,741 – 91,649	0,000
Sleep Quality Good						
Poor	0,59	0,211 – 1,632	0,307	0,49	0,147 – 1,605	0,236

[a]Unadjusted; [b]Confounding variables: sex, education level, occupation, body fat, and muscle mass. *Logistic regression, significant (p<0,05).

In this study, the participants were middle-aged and elderly, and the average participant consumed only sensible food based on availability, economic factors, and selection of certain foods. The majority of subjects consume cheap food, often found in the surrounding environment, less diverse, and do not meet balanced nutritional guidelines; for example, consuming the same food every day because it is cheap and easy to find, consuming vegetables and animal food only at certain times, food processing is less varied, and the vegetables and fruits consumed are less diverse. For example, the average subject consumes bananas, papayas, and oranges more often because they are easy to find, more affordable, and like to eat frozen food. This can affect food consumption quality scores. Several factors that influence unhealthy eating patterns, such as cost, food availability, and cultural acceptance, are barriers to promoting healthy eating patterns (Poti et al. 2016; Wardani et al., 2024). Improving the quality of food consumption at a younger age can have a positive effect on physical performance in older age. Dietary patterns play a crucial role as modifiable factors in maintaining health and preventing chronic diseases associated with aging. AHEI scores are generally low and may indicate a poor diet. Improving the quality of food consumption across a lifespan can delay the decline in body function (Talegawkar et al., 2021).

Tabel 4. Average AHEI score

Component	Mean ± SD (Median)
Vegetables	4,7 ± 2,2 (5,0)
Fruit	5,4 ± 2,6 (5,4)
Grains/staple food	9,9 ± 0,3 (10)
Sugar-sweetened beverages	3,2 ± 4,3 (0,0)
Nuts	5,6 ± 2,1 (5,0)
Red/processed meal	8,5 ± 2,9 (10)
Trans fat	2,8 ± 0,8 (3,0)
Long-chain (n-3) fats	0,2 ± 0,3 (0,1)
PUFA	3,3 ± 1,2 (3,1)
Sodium	8,5 ± 3,6 (10)
Alcohol	10 ± 0,0 (10)
Total AHEI score	62,2 ± 7,9 (61,5)

Table 4 shows that the average total score of the AHEI is 62,2 points, which means that the overall total score is still less than expected because it does not match the score limit and nutritional guidelines. The average score that has the maximum score (10) is the alcohol component of food and beverage consumption

habits in Indonesia, where alcohol consumption is a taboo, especially among the elderly. The average grain/staple, red/processed meat, and sodium almost reached the maximum score (10). Grains/staple foods are consumed daily, especially white rice. All participants in this study consumed rice daily, and only the portion and frequency of eating differed. Red meat and its preparations are consumed more often in processed forms, such as sausages, corned beef, and meatballs. The nuts consumed included capri beans, peanuts, peas, and egg beans. Sodium is used in various types of food and in various other forms. Natural sources of Na can be found in food, whether from plants or animals. In general, foods from animal sources tend to contain more sodium. Most raw foods contain approximately 10% sodium, with an additional 90% introduced during cooking (Amir & Said, 2018). The average AHEI scores for vegetables, fruits, sugar-sweetened beverages, nuts, omega 3, trans fat, and PUFA are far from the maximum because consumption of vegetables and fruits is usually seasonal, and only certain fruits can be consumed every day. In addition, foods containing PUFA and omega-3 are usually found in foods such as nuts, fish, seafood, and their preparations, which still need to be regularly consumed (Waloya et al., 2013).

Some question items on the Sedentary Behavior Questionnaire (SBQ) are the intensity of watching TV, videos, and DVDs, playing computers, talking on the phone, listening to music or radio, sending messages or playing, doing work/lectures, reading books or magazines, playing musical instruments, doing art or craft activities, and driving (with motorbikes, cars, or public transportation). The results of the chi-square test showed a p-value of 0,00, which means a significant association exists between a sedentary lifestyle on weekdays and weekends and the incidence of obesity among middle-aged and older adults. Similar to Table 3, a sedentary lifestyle on weekdays and weekends was associated with the incidence of obesity. The OR for a sedentary lifestyle on weekdays was 8,014, which means that participants with a high level of sedentary lifestyle on weekdays were eight times more likely to be obese than those with a low sedentary lifestyle. The OR for a sedentary lifestyle on weekends was more significant at 18,516, which means that participants with a high level of sedentary activity on weekends were 18 times more likely to be obese than those with a low sedentary level. This is in line with Amrynia & Prameswari (2022), who state that there is an association between sedentary lifestyle and the incidence of overweight (Amrynia & Prameswari, 2022; Rahmad, 2021). Lifestyle transitions cause sedentary activities and a lack of physical activity to continue to increase. Current technological advances aim to make fokawir faster and easier for all the activities. However, as a result, people must become more mobile. For example, machines make household chores more accessible and reduce physical activity, thereby increasing the likelihood of a more sedentary lifestyle.

An inactive lifestyle results in previously unused energy for activity that is then stored as fat, which can lead to obesity (Rini & Novitasari, 2015). In addition, a study by Ohlsson et al. (2020) stated that the cause of weight gain is a long sitting duration. In the SBQ questionnaire, all question items were related to sitting activities; in this study, more subjects had highly sedentary activities. The impact of prolonged sitting behavior has been widely evaluated, and several musculoskeletal problems such as neck pain, back pain, and joint problems are common in individuals who perform work that involves little movement. Prolonged sitting can lead to significant muscle and bone fatigue and chronic pain, and can trigger postural imbalances (Hanna et al., 2019; Labatjo et al., 2023). Sedentary behavior has a significant impact on the overall health of the population. It can lead to increased rates of non-communicable diseases and even death (approximately 6% of the world's total deaths) (Park et al., 2020).

The results of the chi-square test were p = 0,398, indicating that there was no association between sleep quality and the incidence of obesity among middle-aged and older adults. The multivariate test results were the same, indicating that the two variables were unrelated (p=0,236). The OR for sleep quality was less than 1 (OR=0,486), indicating a negative association between the two. This could be because there are other factors that influence obesity, besides sleep quality. This is in line with Sinaga et al. (2015) related to the association between sleep quality and BMI, which states that there is no association between sleep quality with BMI (Sinaga et al., 2015) and in line with

Kawi et al. (2019) related to the effect of obesity on sleep quality which concluded that obesity has no significant effect on sleep quality (Kawi et al., 2019). However, this study are not in line with Patel et al., 2014, which states that in the elderly of all genders, high variability in sleep duration during the day and night is associated with obesity cases, the results of the study indicate that sleep characteristics have an effect in weight homeostasis.

In this study, both obese and non-obese subjects mostly had poor sleep quality, which can be attributed to the fact that the elderly tend to go to bed earlier and wake up earlier than other age groups. The shift in sleep time is caused by circadian rhythms generated by pacemakers located in the suprachiasmatic nucleus (SCN) of the hypothalamus. The aging process is associated with a decline or malfunction of SCN sensitivity to environmental cues to adjust the circadian rhythm to the natural 24-hour cycle of day or night. Melatonin levels also decrease with age and reach levels similar to the daytime concentrations, contributing to the increased prevalence of sleep-related disorders with age. Sleep homeostasis declines with age. Sleep efficiency may be partly due to age-related reduction in homeostatic sleep pressure (Duffy et al., 2015).

Various studies have reported an association between sleep duration and obesity. A meta-analysis found that each one hour reduction in sleep per day correlated with a 0,35 kg/m^2 increase in Body Mass Index (BMI). These changes that occur because of sleep deprivation suggest a potential imbalance between food intake and energy expenditure caused by neuroendocrine changes. Sleep deprivation can affect eating patterns owing to decreased leptin and increased ghrelin secretion, which can lead to increased hunger and appetite, leading to increased food consumption (Medic et al., 2015; Medic et al., 2017).

This study has several limitations, namely, the age range of respondents is too far from 40 to 80 years, which can affect the variables of sedentary lifestyle and sleep quality. In the AHEI, the cut-off value of the maximum score for the components of trans fat, PUFA, red meat/processed meat, and sugar-sweetened beverages does not yet have a cut-off specifically for Indonesians and according to portions.

Conclusion

There were more cases of obesity among the respondents than among those who were not obese. Most respondents reported food consumption quality that needed improvement, high levels of sedentary lifestyle, and poor sleep quality. A sedentary lifestyle on weekdays and weekends is associated with the incidence of obesity, while the quality of food consumption based on AHEI and sleep quality are not associated with the incidence of obesity.

In addition, confounding variables, such as education level, occupation, fat mass, and muscle mass were also influenced. Due to the high incidence of obesity, it is necessary to take preventive and reductive measures to prevent and reduce the occurrence of obesity in the community through counseling, nutrition education, healthy gymnastics activities, and various other programs that can improve the quality of food consumption, sleep quality, and reduce sedentary lifestyles. Therefore, further research is needed regarding interventions against the incidence of obesity

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