The relationship between energy and macronutrient intake with nutritional status in Sundanese young women with high body fat

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Abstract. Obesity prevalence among Indonesian women has notably risen, potentially due to shifts in dietary patterns and lifestyle changes. This research explored the association between energy and macronutrient intake and the nutritional status of Sundanese young women with high body fat. The study involved 88 Sundanese women aged 18 to 25 years, all of whom had a total body fat percentage exceeding 35%. Dietary intake was assessed using a semi-quantitative food frequency questionnaire to estimate energy and macronutrient consumption. The result shows that energy intake had a weak negative relationship with waist circumference ($r = -0.221$, $P = 0.039$) and body fat ($r = -0.278$, $P = 0.009$). Similarly, fat intake exhibited a weak negative relationship with body fat ($r = -0.216$, $P = 0.043$). Carbohydrate intake was weakly negatively related to body weight ($r = -0.223$, $P = 0.037$) and body fat ($r = -0.246$, $P = 0.021$) while demonstrating a moderate negative relationship with waist circumference ($r = -0.310$, $P = 0.003$). Additionally, fiber intake showed a weak negative correlation with waist circumference ($r = -0.253$, $P = 0.017$). This absence of association may be due to the chronic and cumulative nature of obesity development, which occurs over time and may not align directly with current intake levels. The study's design may have resulted in a temporal mismatch as current intake may not accurately reflect the long-term dietary patterns contributing to obesity.

1 Introduction

As the largest archipelagic state globally and the fourth most populous nation, Indonesia faces an increasing burden of non-communicable diseases (NCDs), with cardiovascular disease becoming a leading cause of mortality. Both the World Health Organization (WHO) and national health authorities have raised concerns regarding the escalation of NCD risk factors, particularly hypertension and obesity, exacerbated by rapid changes in dietary habits and lifestyle among Indonesians. Obesity, a key contributor to cardiovascular disease, is notably prevalent in Indonesian women, with rates nearly double the global average. This trend

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reflects broader global patterns, where obesity rates have incresed in low- and middle-income countries, driven by urbanization, greater availability of energy-dense foods, and shifts toward sedentary lifestyles [1].

Recent health statistics underscore the urgency of addressing obesity in Indonesia. According to the 2023 Indonesian Health Survey, obesity affects 23.4% of adults aged 18 and above, reflecting a significant increase in recent years [2]. Gender-specific disparities are particularly concerning, as obesity prevalence among Indonesian women is nearly twice that of the global female population [3]. Young women with high body fat are at a heightened risk of developing severe health conditions, including metabolic syndrome, cardiovascular diseases, type 2 diabetes, specific types of cancer, and an increased likelihood of mortality [4]. This pattern suggests that gender-specific factors, including social, cultural, and behavioral elements, may contribute significantly to the risk profile in women. Dietary behaviors, such as the intake of energy-dense but nutrient-deficient foods, often contribute, especially as Indonesian dietary patterns shift from traditional diets to those higher in processed foods and refined sugars [5].

Despite the well-documented increase in obesity across Indonesia, limited research has focused on specific subgroups, such as Sundanese young women, who may have distinct dietary and cultural practices affecting their health. Women in this age range transition from adolescence to adulthood, often experiencing major lifestyle shifts, for instance, pursuing higher education, joining the workforce, or establishing independent living habits [6]. Young women in urban areas like Bandung may have reduced physical activity due to sedentary lifestyles associated with academic or professional commitments. Additionally, Sundanese culture emphasizes traditional foods, which may be high in carbohydrates and fats, such as high-calorie traditional Sundanese foods or sugary beverages. These changes can influence dietary and physical activity patterns, potentially increasing obesity risk [7]. Data from the Indonesian Basic Health Research shows that intake of dietary fat accounts for an average of 25.6% of total daily intake among Indonesian adults, reflecting a high consumption of energy-dense foods [8]. However, no studies have examined the specific nutrient intake and dietary patterns of young Sundanese women, who may exhibit unique risk factors or protective behaviors relevant to obesity. The objective of this study was to examine the association between energy and macronutrient intake and nutritional status in young Sundanese women with elevated body fat.

2 Materials and methods

2.1 Study design, time, and location

This research employed a cross-sectional design, a commonly used framework in public health and epidemiological studies which captures data at a single point in time. Data collection took place from August to November 2023 in Bandung City, encompassing participant recruitment, data gathering, and initial analysis, ensuring a compilation of a robust dataset for subsequent evaluation. This study was approved by the Ethics Committee of Padjajaran University under reference number 1068/UN6.KEP/EC/2023.

2.2 Subjects

To ensure consistency and relevance to the research objectives, the study applied specific inclusion criteria: participants were required to be women with obesity, defined by a total body fat exceeding 35% [9], of Sundanese ethnicity, aged between 18 and 25 years, and willing to provide informed consent. Exclusion criteria were established to minimize confounding factors; pregnant or breastfed participants, had a history of chronic disease, or were participating in other research studies.

2.3 Sampling

The study focused on women aged 18 to 25 years from the Sundanese ethnic group who were classified as obese, defined by a total body fat percentage exceeding 35%. The Lemeshow formula determined the sample size to ensure adequate statistical power for the analysis. Participants were selected through purposive sampling.

2.4 Instruments

All data were collected using a questionnaire. The Nutrisurvey 2007 diet software was used to analyze nutritional intake, with data from the Indonesian Food Composition Table. An Omron Karada Scan HBF-375 body composition monitor (Japan), SAGA stadiometer (Indonesia), and OneMed flexible measuring tape (Indonesia) were used to collect anthropometric data.

2.5 Data collection

Data collection included the participant's characteristics, such as name, age, education, and occupation, as well as body composition data, i.e. body weight, fat percentage, height, waist circumference, and hip circumference were collected. The scale was placed on a hard, flat surface to ensure accuracy, and the stadiometer was mounted on a flat wall. Before measurements, participants were instructed to remove heavy clothing, shoes, and accessories. Weight was measured in kilograms (kg) with a precision of 0.1 kg, total body fat was recorded as a percentage (%), and height was measured in centimeters (cm) with an accuracy of 0.1 cm. For waist and hip circumference, participants stood upright with feet together and wore light clothing or adjusted clothing to expose the waist and hip areas. Waist circumference was determined by placing a measuring tape horizontally around the narrowest section of the torso, positioned between the lowest rib and the top of the iliac crest. Hip circumference was measured at the widest part of the hips, typically covering the most prominent area of the buttocks. Participants were instructed to exhale normally before the measurement, which was recorded in centimeters to the nearest 0.1 cm. Using the collected data, body mass index and waist-to-hip ratio were calculated.

Dietary intake data was gathered via physical forms using an SQ-FFQ (semi-quantitative food frequency questionnaire). All data were entered, cleaned, and then quantified to 'times per day'. Furthermore, each food item's frequency and portion size were multiplied, and the resulting data were analyzed for energy, carbohydrate, fat, protein, polyunsaturated fatty acid (PUFA), and fiber intake. These nutrients are crucial for understanding the relationship between diet and obesity, as excessive energy-dense food intake can contribute to gaining weight and associated health risks. Average intake was calculated as the mean intake of energy and macronutrient intake among participants, while the average adequacy was determined as the percentage of intake compared to the recommended daily intake. The intake categories were based on cut-off values for macronutrient intake.

2.6 Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics software (version 26.0, SPSS Inc., Chicago, IL, USA). The Kolmogorov-Smirnov test was applied to evaluate the normality of data distribution, determining whether the variables followed a normal distribution. To examine the relationships between nutrient intake (including energy, protein, carbohydrates, fats, polyunsaturated fatty acids (PUFA), and fiber) and various indicators of nutritional status (such as body weight, body mass index, waist circumference, hip circumference, waist-to-hip ratio, and total body fat), Spearman's rho correlation analysis was utilized.

3 Results and discussion

3.1 General characteristics and nutritional status

Table 1 presents the general characteristics and nutritional status of the study participants. All individuals included in the study were of Sundanese ethnicity, defined as having at least one parent of Sundanese descent. The participants had a mean age of 20.3 ± 1.87 years, with most having completed high school or its equivalent and currently pursuing higher education in Bandung.

A significant proportion of the subjects (72.7%) had a BMI classified as obese (≥30 kg/m²) according to WHO standards, while 27.3% were classified as non-obese. Waist circumference measurements indicated that 93.2% of participants were in the 'at-risk' category, with a mean ± SD waist circumference of 95.0 ± 9.12 cm, suggesting a potential predisposition to metabolic complications. Additionally, the waist-to-hip ratio analysis revealed that 42% (37 participants) were in the 'at-risk' range, further supporting the association between elevated central adiposity and higher health risks [10].

Table 1. Overview of participant's characteristics and nutritional status

Variable	Category	n	%	Mean ± SD
Age	18-25 y.o.	88	100.0	20.34 ± 1.87
Education	High school College	75 13	85.2 14.8	-
Occupation	Student Private sector Public sector Other	72 2 3 11	81.8 2,3 3,4 12.5	-
Body weight (BW)	-	88	100.0	81.5 ± 11.75
Height	-	88	100.0	158.3±5.69
Body mass index (BMI)	Not Obese (<30 kg/m^2) Obese (≥ 30 kg/m^2)	24 64	27.3 72.7	32.54 ± 4.46
Waist circumference (WC)	No risk (<80cm) At risk (≥80 cm)	6 82	6,8 93.2	94.97 ± 9.12
Waist-hip ratio (WHR)	No risk (≤0.85) At risk (>0.85)	51 37	58.0 42.0	0.84 ± 0.04
Total body fat (TBF)	Not obese (≤35%) Obese (>35%)	0 88	0.0 100.0	38.31 ± 2.68

*SD (Standard Deviation)

3.2 Energy and nutrient intake

Table 2 displays the average intake and nutrient adequacy levels among the study participants. Analysis reveals that the calculated energy and macronutrient intakes predominantly fall within the deficit category, which appears contradictory given the obese status of the participants. This discrepancy suggests potential food intake under-reporting, commonly observed in dietary assessments using self-reporting methods. Consequently, it is reasonable to assume that the actual intake levels, particularly for energy and macronutrients, might be higher than reported, potentially resulting in fat intake exceeding the recommended threshold (≥120%). Under-reporting, particularly among individuals with higher body weight, is a well-documented issue that can obscure the relationship between diet and nutritional status [11]. Addressing this limitation in dietary assessments is essential for ensuring accurate data collection and enhancing our understanding of the dietary factors contributing to obesity, thereby informing targeted interventions to improve nutritional health among young adults.

Table 2. Average intake and adequacy

Nutrients	Unit	Average Intake	Average Adequacy (%)	Category
Energy	Cal	1523±619.8	72.4±30.68	Moderate Deficit
Proteins	g	47.2±35.94	81.3±59.44	Mild Deficit
Fat	g	70.0±33.35	111.9±56.77	Normal
PUFA	g	9.9±9.26	81.6±79.85	Mild Deficit
Carbohydrate	g	179.0±73.15	54.1±23.19	Severe Deficit
Fibre	g	7.4±5.16	24.7±16.46	Severe Deficit

*All data shown as Mean ± SD (Standard Deviation)

3.3 Relationship between energy and macronutrient intake and nutritional status

Analysis of the correlation between energy intake and macronutrients of participants (Table 3) revealed that energy intake had a weak negative relationship with waist circumference and total body fat. Protein and PUFA intake showed no significant relationship with any indicators of nutritional status ($P \geq 0.05$). Fat intake exhibited a weak negative relationship with the participant's total body fat, while carbohydrate intake had a weak negative relationship with body weight and total body fat, and a moderate negative relationship with waist circumference. Fibre intake had a weak negative relationship with the subject's waist circumference. Energy and macronutrient intake had no relationship with BMI and waist-hip ratio.

Table 3. Correlation test between intake and the subject's nutritional status

Nutrients		BW	BMI	WC	WHR	%BF
Energy	r	–0.206	–0.153	–0.221*	0.000	–0.278**
	P	0.054	0.155	0.039	0.999	0.009
Proteins	r	–0.113	–0.082	–0.103	0.020	–0.206
	P	0.294	0.446	0.339	0.851	0.054
Fat	r	–0.160	–0.104	–0.082	0.039	–0.216**
	P	0.136	0.334	0.446	0.718	0.043
PUFA	r	–0.199	–0.121	–0.122	–0.035	–0.199
	P	0.064	0.263	0.257	0.746	0.063
Carbohydrate	r	–0.223*	–0.175	–0.310**	–0.028	–0.246**
	P	0.037	0.103	0.003	0.793	0.021

Table 3. Correlation test between intake and the subject's nutritional status (continue)

Nutrients		BW	BMI	WC	WHR	%BF
Fiber	r	–0.157	–0.124	–0.253*	–0.199	–0.183
	P	0.144	0.248	0.017	0.063	0.088

*A correlation is considered significant at the 0.05 level (two-tailed); **A correlation is considered significant at the 0.01 level (two-tailed). BW: Body Weight, BMI: Body Mass Index, WC: Waist Circumference, WHR: Waist-Hip Ratio, %BF: Percent of Body Fat.

The negative relationship indicates a unidirectional association that is not entirely explained by confounding factors, such as eating patterns and inappropriate reporting (under-reporting and under-estimation). Data on dietary intake captured in this study may not fully represent the cumulative eating behaviors that contribute to the gradual development of obesity. The absence of a clear association may be due to the chronic and cumulative nature of obesity, which develops gradually over time and may not directly correlate with current dietary intake [12]. However, based on the data, researchers hypothesized that individuals with higher nutritional status, such as having a greater body weight, waist circumference, or total body fat, tended to report consuming less food, resulting in a negative relationship between reported energy and nutrient intake with the actual nutritional status. Underreporting is a well-recognized issue in dietary surveys, often assessed by calculating the reported energy intake (EI) ratio to basal metabolic rate (BMR), or EI/BMR. Study indicates that overweight and obese individuals typically exhibit lower EI/BMR ratios compared to those with normal weight. This discrepancy may reflect not only unreported food consumption but also instances of extreme short-term energy restriction among individuals with obesity [13]. A threshold of 1.35 for EI/BMR has been established, derived from principles of energy physiology, representing the minimum energy intake required to sustain normal physiological functions. Values below this cut-off are commonly used to identify underreporting in dietary assessments. However, some research contradicts the underreporting theory; suggesting that adults with stable body weight and individuals with obesity do not report lower food intake than those without obesity [14]. SQ-FFQs are effective for evaluating long-term dietary patterns in large-scale studies, while 24-hour recalls provide more precise and detailed insights into short-term intake. Both methods are susceptible to underreporting, but their reliability can be improved through careful study design, validation processes, and the integration of complementary methods [15].

4 Conclusion

Limitations in the study design may have introduced a temporal disconnect, as assessing of current dietary intake may not accurately reflect long-term eating habits contributing to obesity. However, incorporating methods like EI/BMR ratios to identify underreporting is a strength of this study. These findings emphasize the importance of accurate dietary assessment tools, as standard instruments like the Semi-Quantitative Food Frequency Questionnaire (SQFFQ) may insufficiently capture actual intake, particularly among obese individuals where underreporting is prevalent. To improve data accuracy, the study recommends incorporating complementary dietary assessment methods, such as 24-hour food recalls or detailed food records conducted twice within 24 hours. These methods provide more precise intake estimations. By integrating these tools, researchers can better evaluate dietary patterns and effectively design interventions to enhance the nutritional status of obese young adults.

Acknowledgements

All author thanks Ms. Vetty Nur Aeni, S.TRGz and the UPI FPOK Nutrition Study Program student team for collaborating to collect data from respondents. We also feel grateful to all respondents involved in this research.

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https://doi.org/10.1051/bioconf/202517103009

Supplementary data

Participant ID	Reported EI (kcal)	BMR (kcal)	EI/BMR (kcal)	Underreporting status
1	1425.1	1462	0.97	underreporting
2	1542.3	1318	1.17	not underreporting
3	1767.4	1587	1.11	not underreporting
4	1278.1	1311	0.97	underreporting
5	1282.1	1733	0.74	underreporting
6	2203.8	1589	1.39	not underreporting
7	1413.4	1407	1.00	not underreporting
8	1774.7	1730	1.03	not underreporting
9	694.8	1657	0.42	underreporting
10	1723.8	1586	1.09	not underreporting
11	1457.5	1679	0.87	underreporting
12	1127.1	1703	0.66	underreporting
13	979.2	2068	0.47	underreporting
14	1618.7	1690	0.96	underreporting
15	1737.5	1387	1.25	not underreporting
16	2588.4	1575	1.64	not underreporting
17	1276.9	1915	0.67	underreporting
18	985.6	1644	0.60	underreporting
19	1863.4	1450	1.29	not underreporting
20	1098.3	1277	0.86	underreporting
21	746.4	1425	0.52	underreporting
22	1869.1	1349	1.39	not underreporting
23	1549.9	1233	1.26	not underreporting
24	1263.1	1533	0.82	underreporting
25	1359.9	1656	0.82	underreporting
26	1338.6	1436	0.93	underreporting
27	1641.9	1479	1.11	not underreporting
28	1220.2	1639	0.74	underreporting
29	2366.6	1628	1.45	not underreporting
30	1658.8	1393	1.19	not underreporting
31	1521.5	1654	0.92	underreporting
32	964.6	1530	0.63	underreporting
33	1343.4	1774	0.76	underreporting
34	1279.2	1625	0.79	underreporting
35	1351.6	1606	0.84	underreporting
36	751.8	1757	0.43	underreporting
37	1366.5	1570	0.87	underreporting
38	1574.2	1359	1.16	not underreporting
Mean	1523.2	1564.7	0.99	

EI: Energy Intake, BMR: Basal Metabolic Rate