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Association of nutrient intake and body mass index among women diagnosed with Polycystic Ovary Syndrome (PCOS)

Hubungan antara asupan gizi dan indeks massa tubuh pada wanita dengan Diagnosis Sindrom Ovarium Polikistik (PCOS)

Yumaizar Fitria[1*], Etika Ratna Noer[2]

[1] Department of Nutrition, Faculty of Medicine, Diponegoro University, Semarang, Indonesia.
E-mail: yumaizar23@gmail.com
[2] Department of Nutrition, Faculty of Medicine, Diponegoro University, Semarang, Indonesia.
E-mail: etikaratna@fk.undip.ac.id

***Correspondence Author:**
Department of Nutrition, Faculty of Medicine, Diponegoro University, Semarang, 50275, Indonesia.
Email: yumaizar23@gmail.com

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Abstract

Polycystic ovary syndrome (PCOS) is a prevalent hormonal disorder affecting women of reproductive age and is frequently associated with being overweight or having obesity. This condition can elevate the risk of metabolic complications and infertility; therefore, early intervention through nutritional strategies is crucial. This study aimed to examine the association between dietary intake and body mass index (BMI) in women diagnosed with PCOS. A cross-sectional design was used, involving 30 participants in Semarang, conducted from September to November 2024. Data on nutrient intake, including energy, carbohydrates, protein, and fat, were collected using a semi-quantitative food frequency questionnaire (SQ-FFQ). Body weight was measured using a digital scale and height was measured with a portable stadiometer (Seca). Data were analyzed using Pearson's correlation tests. The results of the study showed a significant correlation between protein, energy, and fat intake and BMI ($p<0.01$), while the correlation between carbohydrate intake and BMI was not significant ($p=0.060$). Protein intake was strongly correlated with BMI ($r=0.640$), followed by energy ($r=0.531$), fat ($r=0.470$), and carbohydrates ($r=0.347$). In conclusion, the results highlight the significance of macronutrient intake management, especially protein, in weight control for women with PCOS.

Keywords: BMI, carbohydrate, nutrient intake, obesity, PCOS

Abstrak

Sindrom Ovarium Polikistik (PCOS) merupakan gangguan endokrin yang umum terjadi pada wanita usia reproduktif dan sering dikaitkan dengan kelebihan berat badan serta obesitas. Kondisi ini dapat meningkatkan risiko komplikasi metabolik dan infertilitas, sehingga penanganan dini melalui pendekatan nutrisi menjadi sangat penting. Penelitian ini bertujuan untuk menganalisis hubungan antara asupan makanan dan indeks massa tubuh (IMT) pada wanita dengan PCOS. Studi ini menggunakan desain *cross sectional* dan melibatkan 30 partisipan di Kota Semarang pada bulan September hingga November 2024. Data mengenai asupan zat gizi, termasuk energi, karbohidrat, protein dan lemak dikumpulkan menggunakan Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ). Berat badan diukur menggunakan timbangan digital dan tinggi badan dengan *portable stadiometer* (merk Seca). Analisis data dilakukan dengan SPSS versi 25 dan analisis bivariat menggunakan uji korelasi Pearson. Hasil penelitian menunjukkan bahwa terdapat hubungan signifikan antara asupan protein, energy dan lemak dengan IMT ($p<0,01$), sedangkan korelasi antara karbohidrat dan IMT tidak signifikan ($p= 0,060$). Asupan protein memiliki korelasi paling kuat dengan IMT ($r=0,640$), diikuti

oleh energi (r= 0,531), lemak (r = 0,470) dan karbohidrat (r = 0,347). Kesimpulan, temuan ini mendukung pentingnya pengaturan asupan gizi makro, khususnya protein, dalam pengelolaan berat badan pada wanita dengan PCOS.

Kata Kunci: Asupan gizi, IMT, karbohidrat, obesitas, PCOS

Introduction

Polycystic ovary syndrome (PCOS) is a prevalent hormonal disorder in women of reproductive age, characterized by irregular ovulation, elevated androgen levels, and the formation of numerous small cysts on the ovaries. This condition not only affects fertility but also increases the risk of various long-term health complications, including insulin resistance, type 2 diabetes, dyslipidemia, and cardiovascular disease (Zaeemzadeh et al., 2021). PCOS is commonly observed in women of reproductive age worldwide. Given its significant impact on health, it is important to explore how dietary patterns or nutritional interventions can help manage this condition. Although PCOS is most commonly associated with obesity, it can also occur in women with normal body weight (Jain et al., 2025).

PCOS is often associated with metabolic syndrome, which includes conditions such as obesity, insulin resistance, and abnormal lipid levels. The prevalence of PCOS in adolescents is estimated to be between 11% and 26%, with approximately half of the affected individuals being overweight. Recent research has shown that overweight or obese women have a higher risk of developing PCOS, with approximately 30% having a body mass index (BMI) of > 30 kg/m^2 (Kurniawati et al., 2022). According to Amiri et al., a positive association exists between the prevalence of obesity and PCOS, with a 1% increase in obesity within a population being associated with an approximately 0.4% increase in the prevalence of PCOS, based on the Rotterdam criteria (Amiri et al., 2024). Zheng et al. reported that 80.2% of women with PCOS in their study were classified as overweight or obese (Zheng et al., 2021).

Nutritional status, especially body mass index (BMI), is one of the primary factors linked to PCOS. Multiple studies have demonstrated that most women diagnosed with PCOS tend to be overweight or obese, which can exacerbate PCOS symptoms, such as menstrual irregularities, acne, and excessive hair growth. In addition, daily dietary intake, both in terms of quality and quantity, is suspected to play a role in the development and severity of PCOS (Qamar et al., 2024). That dietary patterns characterized by a high glycemic index and high fat intake were associated with an increased risk of PCOS. Conversely, adherence to an anti-inflammatory diet appeared to have a protective effect against the development of PCOS (Panjeshahin et al., 2020). An unbalanced dietary intake characterized by a high consumption of simple carbohydrates and saturated fats, along with a low intake of fiber and protein, has the potential to exacerbate insulin resistance and chronic inflammation, both of which are closely linked to PCOS. Therefore, understanding the relationship between dietary patterns and BMI in women with PCOS is crucial to support comprehensive and lifestyle-based management strategies (Barrea et al., 2018).

Diet quality plays a crucial role in influencing body mass index (BMI) and metabolic function. Diets rich in fiber, low in saturated fats, and abundant in fruits, vegetables, and low-glycemic index foods have been associated with reduced fat accumulation and better insulin response. Conversely, diets high in calories, refined carbohydrates, and trans fats are associated with a greater likelihood of becoming overweight, developing central obesity, and experiencing metabolic conditions, such as insulin resistance and abnormal lipid profiles. Several studies have demonstrated that small but consistent dietary changes can significantly impact weight management, particularly in women of reproductive age, who are vulnerable to metabolic disorders, such as polycystic ovary syndrome (PCOS). Therefore, making appropriate food choices represents a key strategy for the prevention and management of weight-related and metabolic health issues (Cunha et al., 2019).

Kulshreshtha et al. reported that total energy intake and macronutrient composition were similar between women diagnosed with

PCOS and the control subjects. However, women with PCOS consumed more "junk" food and less dietary fiber. This suggests that although caloric and macronutrient intake may be similar, the overall dietary quality among women with PCOS tends to be lower. A dietary pattern high in sugar and saturated fat but low in fiber may worsen insulin resistance, chronic inflammation, and hormonal imbalances, key features of PCOS. Furthermore, the same study found that women with PCOS were more likely to skip or delay meals, such as breakfast, which can disrupt the metabolic circadian rhythm and exacerbate hormonal dysregulation (Kulshreshtha et al., 2022).

Despite growing interest in the dietary aspects of PCOS, few studies have specifically investigated the association between individual macronutrient intake and body mass index (BMI) in women with PCOS, particularly in the Indonesian context. This study aimed to analyze the relationship between dietary intake, focusing on energy, carbohydrates, protein, and fat, and BMI in women with PCOS. The novelty of this study lies in its focus on the quantitative association between specific macronutrient intake and BMI among Indonesian women with PCOS, which remains underexplored in the existing literature.

Methods

This observational study employed a cross-sectional design and was conducted in Semarang City, Central Java Province, between September and November 2024.

Participant selection was performed using a nonprobability consecutive sampling method. The sample size was determined using the Lemeshow formula, with a confidence interval of 95% (Z = 1.96), margin of error (d) of 10%, and estimated proportion of the disease of interest from previous data of 10% (p = 0.10). To anticipate potential dropouts, the sample size was increased by 10%, resulting in a final sample size of 30 participants.

$$n = \frac{(za)^2 P(1-p)}{d^2}$$

Participants were women aged 18 to 40 years who had been diagnosed with polycystic ovary syndrome (PCOS) according to the Rotterdam criteria, with confirmation by an obstetrician and gynecologist. Women who were pregnant or had a history or current diagnosis of diabetes mellitus were excluded from the study.

Nutrient intake data, including energy, carbohydrates, protein, and fat, were collected using a semi-quantitative food frequency questionnaire (SQ-FFQ) that included food items commonly consumed by the population in Semarang City. Respondents were asked to report the frequency and portion size of each food item consumed over the past month. The SQ-FFQ instrument used in this study was adapted from a previously validated questionnaire and has demonstrated acceptable levels of validity and reliability in similar population-based studies (Syauqy et al., 2021). Body weight was measured using a digital scale, with participants instructed to wear light clothing and no footwear during the measurement. Height was measured using a portable stadiometer (Seca brand) with an accuracy of 0.1 cm, with participants standing upright, barefoot, and with heels together.

Data analysis was performed using SPSS version 25. The normality of the data was assessed using the Shapiro–Wilk test, and all variables were found to be normally distributed ($p > 0.05$), justifying the use of parametric tests. Subsequently, bivariate analysis was conducted to evaluate the relationship between the independent variables (energy, carbohydrate, protein, and fat intake) and the dependent variable, body mass index (BMI). Pearson's correlation analysis was used for the bivariate analysis. However, the analysis did not control for potential confounding variables, such as age, physical activity level, or socioeconomic status, which may also influence BMI. No statistical adjustments or stratifications were applied to reduce bias; thus, the findings should be interpreted with caution.

This study was approved by the Ethics Committee of Diponegoro University (approval number: 452/EC/KEPK/FK-UNDIP/VIII/2024).

Result and Discussion

Table 1 presents the age, weight, and height of the participants (n=39), with a mean age of 29 years (±4.3), an average weight of 64.9 kg (±14.5), and a height of 157.01 cm (±4.5). Most respondents held a D3/S1 level of education (86.6%), while 10%

had a Master's degree. Regarding occupation, the majority worked in the private sector (46.6%), followed by government employees (33.3%). A smaller proportion were unemployed (10%) or self-employed (10%).

Table 1. Participant characteristic

Variables (n=30)	Frequency
Age	29 ± 4.3
Weight	64.9 ± 14.5
Height	157.01 ± 4.5
Education	
Senior high school	3.33%
D3/S1	86.6%
S2	10%
Occupation	
Unemployed	10%
Self-employed	10%
Private sector employee	46.6%
Government employee	33.3%

Table 2 shows that the mean energy intake among participants was 2628.58 ± 727.03 kcal, ranging from 1657.67 to 4981.59 kcal. The mean carbohydrate intake was 376.07 ± 107.77 grams, with a minimum of 240.67 grams and a maximum of 676.16 grams.

The mean protein intake was 132.33 ± 38.21 grams, with a range of 43.55 to 218.40 grams, while the mean fat intake was 84.77 ± 34.71 grams, with a range of 29.25 to 199.95 grams. The mean body mass index (BMI) was 26.57 ± 6.04 kg/m^2, ranging from 17.40 to 39.40 kg/m^2. Based on the BMI classification for Indonesian adults, this mean falls into the obesity Class I category. The minimum BMI value of 17.40 kg/m^2 indicates that some participants were classified as underweight, while the maximum BMI of 39.40 kg/m^2 reflects participants in the obesity Class II category. These findings suggest that the majority of participants had an excess nutritional status, categorized as either overweight or obese (Kementerian Kesehatan Republik Indonesia, 2018).

Table 2. Descriptives statistics of nutrient intake and BMI among participants (n= 30)

Variables (n=30)	Mean ± SD	Min-Max
Energy intake (kcal)	2628,58 ± 727.03	1657.67-4981.59
Carbohydrate intake (gram)	376.07 ± 107.77	240.67-676.16
Protein intake (gram)	132.33 ± 38.21	43.55-218.40
Fat intake (gram)	84.77 ± 34.71	29.25-199.95
BMI intake (kg/m^2)	26.57 ± 6.04	17.40-39.40

Table 3. The association between energy intake, carbohydrate intake, protein intake and fat intake with body mass index

Variables	R	p-value
Energy intake	0.531	0.003
Carbohydrate intake	0.347	0.060
Protein intake	0.640	0.000
Fat intake	0.470	0.009

As presented in Table 3, protein, energy, and fat intake were significantly associated with BMI ($p<0.05$), whereas carbohydrate intake showed no significant correlation ($p=0.060$). Among all nutrients, protein intake showed the highest positive correlation with BMI ($r=0.640$, $=0.000$), followed by energy ($r= 0.531$, $p=0.003$) and fat intake ($r=0.470$, $p=0.009$). In contrast, carbohydrate intake demonstrated a weaker correlation with BMI, which was not statistically significant ($r=0.347$, $p=0.060$). These findings indicate that increased intake of macronutrients particularly protein, energy, and fat is associated with higher BMI among women with PCOS. This positive correlation suggests that a higher intake of these nutrients may contribute to a greater risk of being overweight or obese.

An imbalance in macronutrient intake is one of the key factors threatening women's health, particularly in relation to polycystic ovary syndrome (PCOS). Macronutrients, such as carbohydrates, proteins, and fats, are essential for regulating hormonal balance, supporting energy metabolism, and ensuring the proper functioning of the reproductive system. Excessive intake of refined carbohydrates and saturated fats, combined with inadequate consumption of protein and fiber, can trigger metabolic dysfunction and systemic inflammation. The imbalance in macronutrient intake not only worsens insulin resistance, which is fundamental to PCOS pathophysiology but also interferes with normal ovulatory

processes. Although the present study did not find a statistically significant association between carbohydrate intake and body mass index (BMI), various previous studies have indicated that high carbohydrate consumption, particularly from refined and high-glycemic sources, contributes to weight gain and adiposity (Tehrani & Naz, 2025).

These findings align with the broader literature and underscore the relevance of protein intake, which was found to have the strongest correlation with BMI in our study. A higher protein intake may contribute to increased satiety and improved metabolic responses; however, it also increases total energy intake when not carefully managed. This suggests that not only the quality but also the balance and quantity of macronutrients are crucial in the dietary management of PCOS (Di Lorenzo et al., 2023).

Pro-inflammatory and inflammatory dietary components, such as trans fats, added sugars, and ultra-processed foods, are considered significant triggers for PCOS. The chronic inflammatory response induced by such dietary patterns may impair ovarian function and exacerbate PCOS symptoms. In contrast, foods with anti-inflammatory properties, including fruits, vegetables, legumes, and fatty fish, have been observed to help reduce oxidative stress and inflammation, as well as improve hormonal and metabolic profiles (Azarbayjani et al., 2024).

Women with PCOS are known to have a greater tendency to consume fast food. This eating behavior is often associated with imbalanced energy intake, deficiencies in essential micronutrients, and increased consumption of unhealthy fats and simple carbohydrates. The consumption of fast food, which is characterized by high caloric content and poor nutritional quality, can worsen metabolic health and contribute to the development of central obesity (Tehrani & Naz, 2025).

Overweight and obesity are common among women with PCOS. Unhealthy dietary patterns have been associated with several hallmark features of PCOS, including hyperandrogenemia, polycystic ovarian morphology, and infertility. A positive energy imbalance, resulting from excessive caloric intake and a sedentary lifestyle, is also more commonly observed in women with PCOS than in the general population (Lin et al., 2019).

A study by Shahdadian et al. found that women who adhered to a Western dietary pattern, characterized by high consumption of processed foods, red meat, fast food, sugar, and saturated fats, were twice as likely to develop polycystic ovary syndrome (PCOS). In contrast, women who followed a mixed dietary pattern, combining elements of the Western diet with plant-based components, showed a 66% reduced risk of developing PCOS (Shahdadian et al., 2018).

Additionally, a study by Cutler et al. reported that women with PCOS consumed lower amounts of fiber and magnesium than women without PCOS. Among women with PCOS, those with insulin resistance (IR) had a higher glycemic load than those without IR. Women with PCOS also consumed more calories than their non-PCOS counterparts. Although excess caloric intake, whether due to overeating or physical inactivity, is a common cause of obesity, previous studies have suggested that women with PCOS may have a lower basal metabolic rate and/or reduced postprandial thermogenesis, which may contribute to weight gain (Cutler et al., 2019).

Dietary composition is considered to be a key element in the management of polycystic ovary syndrome (PCOS). Choi et al. found that women who followed the DASH diet, along with a calorie-restricted plan, experienced favorable outcomes in terms of weight management and glucose levels. Weight reduction in obese individuals with PCOS has been shown to positively impact metabolic profiles, including improvements in insulin sensitivity (Choi et al., 2025).

The relationship between obesity, insulin resistance, and PCOS is further emphasized that obesity worsens insulin resistance, one of the key characteristics of PCOS, and leads to elevated levels of insulin and androgens in the body. Therefore, appropriate dietary interventions are necessary. Weight loss in obese individuals with PCOS can positively impact overall health (Mohapatra & Samantaray, 2024). In this context, Kazemi et al. demonstrated that adherence to interventions, particularly the adoption of a healthy dietary pattern, significantly contributes to the success

of lifestyle modification in women with PCOS, including weight reduction (Kazemi et al., 2019).

Zhang et al., in their study, found that a low-carbohydrate diet (LCD) was effective in reducing body mass index (BMI), insulin resistance (HOMA-IR), total cholesterol (TC), and LDL cholesterol levels in women with PCOS. Both long-term LCD and low-fat, low-carbohydrate versions of LCD demonstrated significant benefits, suggesting that such dietary strategies can be recommended for reducing BMI and improving metabolic parameters in patients with PCOS (Zhang et al., 2019).

A study by Mizgier et al. found that increased inflammation and oxidative stress were present in adolescent girls with PCOS who were overweight or obese, particularly in those with low intake of plant-based protein and carbohydrates (Mizgier et al., 2021). This reinforces the idea that a low intake of fiber and protein contributes not only to metabolic dysfunction, but also to inflammatory pathways relevant to PCOS (Vasyukova et al., 2023).

From a practical standpoint, this study highlights the importance of macronutrient balance, especially the regulation of protein and fat intake, in weight management strategies for women with PCOS**.** Dietary counseling tailored to individual needs could support hormonal balance, improve metabolic outcomes, and enhance fertility-related parameters.

However, this study has some limitations. The small sample size, cross-sectional design, and absence of control for potential confounding factors, such as age, physical activity, socioeconomic status, or hormonal therapy, may affect the generalizability of the findings. In addition, the use of a self-reported dietary assessment tool (SQ-FFQ) may have introduced recall bias and measurement errors, which could impact the accuracy of reported nutrient intake. Future research should consider larger longitudinal designs, employ more objective dietary assessment methods, and apply multivariate analysis to account for these variables.

Conclusion

An imbalance in macronutrient intake, particularly high consumption of refined carbohydrates and saturated fats, combined with low intake of protein and fiber, can contribute to metabolic and hormonal disturbances in women with polycystic ovary syndrome (PCOS). This study found that protein intake was strongly correlated with body mass index (BMI), highlighting the potential role of protein regulation in weight management among women with PCOS.

From a practical standpoint, these findings support the importance of dietary interventions that emphasize adequate protein intake and overall macronutrient balance as part of early nutritional strategies to manage PCOS. Maintaining a normal BMI through targeted nutrition may help reduce insulin resistance, inflammation, and ovulatory dysfunction associated with PCOS.

This study is limited by its small sample size, cross-sectional design, and lack of adjustment for confounding variables. Future research should explore these associations using longitudinal approaches and controlled models to better understand causal relationships and develop tailored nutritional guidelines.

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