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Comparative Impact of Black Coffee and Milk Coffee on Prediabetes in Obese Adults

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Abstract

Obesity is a major risk factor for metabolic diseases such as diabetes mellitus, hypertension, and cardiovascular disorders, primarily through the mechanism of insulin resistance. One contributing factor to obesity is the increasing consumption of sugar-sweetened beverages, including milk coffee. However, coffee also contains bioactive compounds with potential protective effects. This study aimed to compare the effects of pure black coffee and milk coffee consumption on prediabetes status and fat mass among obese individuals. An analytical observational study with a cross-sectional design was conducted in Medan City from December 2024 to February 2025 involving 82 obese participants aged 19–45 years. Coffee intake was assessed using a Food Frequency Questionnaire (FFQ), fasting blood glucose levels were measured using spectrophotometry, and fat mass was evaluated with a Body Composition Analyzer. Data were analyzed using a chi-square test with a significance level of $p < 0.05$. Results showed no significant difference in prediabetes incidence between black coffee and milk coffee consumers ($p = 0.925$). Similarly, fat mass did not differ significantly between groups (31.1 ± 7.4 vs. 31.7 ± 7.3). In conclusion, consumption of black coffee or coffee with milk showed no significant effect on prediabetes incidence or fat mass among obese individuals.

Introduction

Obesity remains a global pandemic, as reflected by its high prevalence and the wide range of associated complications observed both in Indonesia and worldwide(Harbuwono *et al*., 2018; Moelyo *et al*., 2025). Over the past two to three decades, obesity has been recognized as a state of low-grade chronic inflammation accompanied by the accumulation and polarization of inflammatory cells in multiple tissues, including adipose tissue, skeletal muscle, liver, pancreas, and brain. This inflammatory response contributes to metabolic dysfunctions such as insulin resistance, type 2 diabetes mellitus, hypertension, cardiovascular disease, and even cancer (Wu & Ballantyne, 2020). Insulin resistance is a common problem in obesity. This condition can be characterized by a prediabetic condition that is still reversible. If left untreated, it can develop into diabetes mellitus, which is irreversible and requires long-term/lifelong treatment. Late diagnosis of diabetes can lead to complications and the need for early screening and diagnosis(Lians *et al*., 2025). In addition, obesity and prediabetes themselves are closely related to a person's fat mass. Especially if the fat mass is >30%, it will increase the risk of complications. This excess fat mass will cause chronic inflammation in the body, which will continue to become

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various complications such as hypertension, diabetes mellitus, coronary heart disease, and cancer. Fat mass is one of the indicators for diagnosing obesity conditions and assessing its comorbidities(Inaishi & Saisho, 2020). Dietary factors play a major role in the development of obesity and insulin resistance, especially through high consumption of sugar-sweetened beverages (SSB).

Sweet drinks, also known as Sugar-sweetened Beverages (SSB), are one of the etiologies of obesity and insulin resistance. Coffee is one of the 7 groups of SSB, where coffee itself has several categories, such as pure coffee and coffee milk(Nasution *et al*., 2022). Coffee, however, exists in various forms—such as pure black coffee and coffee with milk or sugar—which differ in their composition and potential metabolic effects. While sweetened coffee may contribute to excessive sugar intake and promote metabolic disturbances, pure coffee contains bioactive compounds such as chlorogenic acid that exert beneficial effects, including antidiabetic and antioxidant properties(Farah & Lima, 2019). Given these contrasting effects, it is important to understand whether different types of coffee consumption may influence metabolic outcomes in individuals with obesity. Therefore, this study aims to compare the effects of pure coffee and coffee milk intake on prediabetes status and fat mass among obese individuals. The findings are expected to contribute to dietary recommendations regarding safe and beneficial coffee consumption patterns for obesity prevention and management.

Methods

This study employed a comparative analytical design with a cross-sectional approach to compare the intake of pure coffee and coffee milk on prediabetes status and fat mass among obese individuals. The study was conducted in Medan City for three months (December 2024 to February 2025) after obtaining ethical approval from the Health Research Ethics Committee of the Faculty of Medicine, Universitas Muhammadiyah Sumatera Utara (No. 1367/KEPK/FKUMSU/2024). The study population consisted of adult men and women aged 19–45 years. A total of 82 participants were recruited who met the inclusion and exclusion criteria. Inclusion criteria included individuals with a body mass index (BMI) greater than 25 kg/m^2, while exclusion criteria included those diagnosed with diabetes mellitus based on anamnesis, individuals following a specific diet, and pregnant or breastfeeding women. Sampling was performed using a consecutive sampling technique. Eligible participants were then divided into two groups based on their dominant coffee intake pattern: the pure coffee group and the coffee milk group.

Data collection included dietary assessment, biochemical measurement, and body composition analysis. The frequency and type of coffee consumption were assessed using a validated Food Frequency Questionnaire (FFQ). Prediabetes status was determined by measuring fasting blood glucose levels obtained from venous blood samples using a spectrophotometric method. Based on the American Diabetes Association criteria, prediabetes was defined as Fasting Plasma Glucose (FPG) 5.6–6.9 mmol/L (100–125 mg/dL) among individuals without diabetes. Normoglycemia was defined as FPG < 5.6 mmol/L (< 100 mg/dL). Body fat mass was assessed using a Body Composition Monitor (Tanita BC-541). Data was analyzed using the Statistical Package for the Social Sciences (SPSS) version 25. Descriptive statistics were presented as frequency and percentage for categorical data, and as mean ± standard deviation (SD) or median (25th–75th percentile) for continuous data. Normality tests were conducted before group comparisons. An independent t-test or Mann–Whitney U test was used to compare continuous variables between groups, while the chi-square test was applied for categorical variables. A p-value < 0.05 was considered statistically significant.

Results and Discussions

A total of 135 individuals were assessed for eligibility, of which 82 participants met the inclusion criteria and completed the study. Fifty-three participants were excluded due to not meeting the criteria or refusing to participate (Figure 1).

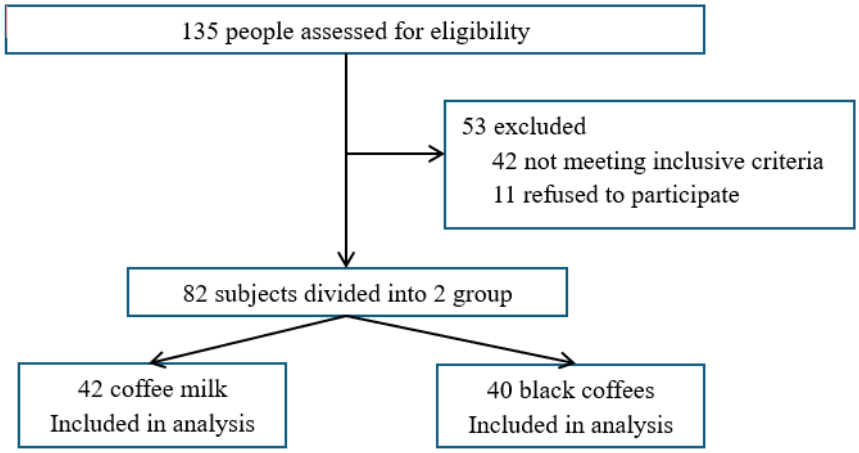

Figure 1. Flow Diagram of the Study

Table 1. Characteristics of Subjects

Characteristics	Black Coffee Group (n=40)	Coffee Milk Group (n=42)
Age, years	36 (26, 44)	34.5 (25, 46)
Gender n (%)		
Male	29 (72.5)	25 (60)
Female	11 (27.5)	17 (40)
Frequency of coffee consumption n (%)		
Infrequent	20 (50)	25 (59.5)
Frequent	20 (50)	17 (40.5)
Body Mass Index (kg/m^2)	29 ± 4.1	28 ± 4.1
Nutritional status n (%)		
Overweight	4 (10)	7 (16.7)
Obese 1	21 (52.5)	24 (57.1)
Obese 2	15 (37.5)	11 (26.2)
Fat mass (%)	31.1 ± 7.4	31.7 ± 7.3
Fasting blood glucose (mg/dL)	95.6 ± 11	94.6 ± 9.5
Prediabetes n (%)		
Yes	12 (30)	13 (31)
No	28 (70)	29 (69)

Source: primary data

The mean age of participants was 35.3 years in the black coffee group and 32.2 years in the coffee milk group. All participants had a BMI >25 kg/m², with the majority classified as obese grade I. No significant differences were found between groups in age, BMI, waist circumference, body weight, or physical activity level ($p > 0.05$), indicating comparable baseline characteristics (Table 1).

In this study, it was found that the male gender was the dominant subject of the study compared to the female. This is related to the habit of drinking coffee, which is associated with the male gender, although nowadays

coffee consumers have started to increase among women. In the Tunisian population, analysis showed that men consumed more coffee than women (Denden *et al*., 2023). Research in Padang also stated the same thing, where the largest coffee consumers are male compared to female, and the type of coffee consumed is black coffee, which is associated with masculinity (Anjani & Hasmira, 2022). Likewise, international research found that women more often avoid coffee because they do not like the taste (64.8% of women vs. 39.4% of men). In addition, women are more aware of the negative effects of coffee on health than men (Demura *et al*., 2013).

The proportion of coffee milk consumers was slightly higher than black coffee consumers, which aligns with previous studies reporting that milk coffee is generally preferred for its lighter and sweeter taste (Spence, C., & Carvalho, 2020). Another survey found that milk coffee and sweet coffee were preferred over black coffee. Milk coffee is more popular among women and Generation Z, while black coffee is more popular among men and the older generation(Wang *et al*., 2024). Then, for the description of prediabetes in this study, it was found that only 30% were found. It turns out that coffee consumers who were participants in the study still have good glycemic control. This is likely related to the age of the subjects of this study, who are still in the productive age range. Prediabetes and diabetes mellitus will increase in incidence in the elderly over 60 years of age(Yan *et al*., 2023). In addition, other factors that influence the incidence of prediabetes are obesity, lack of physical activity, high waist-to-hip ratio, and male gender (Hossain *et al*., 2022; Khamseh *et al*., 2021; Uyangoda & Markmee, 2025). Comparative analysis using the independent t-test revealed no significant difference in fat mass between black coffee and coffee milk consumers (31.1 ± 7.4% vs. 31.7 ± 7.3%, p = 0.711) (Table 2). Similarly, chi-square analysis showed no significant association between the type of coffee consumed and the prevalence of prediabetes (p = 0.925) (Table 3).

From the test, a p-value>0.05 was found, which means there is no difference in fat mass in consumers of coffee with milk and black coffee. Consumption of sweet drinks, also known as sugar-sweetened beverages, can theoretically cause obesity or excess fat mass. However, coffee remains controversial because bioactive compounds such as caffeine and chlorogenic acid may enhance thermogenesis, lipolysis, and fat oxidation, potentially counteracting weight gain when consumed without sugar or high-calorie additives(Van Dam *et al*., 2020). A recent meta-analysis also reported that coffee consumption is modestly associated with lower measures of adiposity, such as body mass index and waist circumference, particularly among men, suggesting a potential protective effect against weight gain(Lee *et al*., 2019). The lack of a significant difference in this study might be due to the fact that black coffee consumption still included added sugar. In addition, variations in coffee drinking frequency, portion size, and duration of habitual intake may have influenced the results. Other lifestyle and biological factors, such as age, physical activity, total caloric intake, stress, and gut microbiota, also play a crucial role in determining fat mass (Cani & Van Hul, 2024; Wewege *et al*., 2022). Future longitudinal or intervention studies are recommended to further investigate the causal relationship between coffee type, sugar content,

Table 2. Comparison of Milk Coffee and Black Coffee Intake on Fat Mass

Type of coffee	Fat mass	Unpaired t-test
Black coffee	31.1 ± 7.4	0.711*
Coffee milk	31.7 ± 7.3	

*significant if p<0.05
Source: primary data

Table 3. Comparison of the Intake of Coffee with Milk and Black Coffee on the Incidence of Prediabetes

Coffee Consumption	Prediabetes		Total	Chi-square
	Yes	No		
	n (%)	n (%)		
Black coffee	12 (30)	28 (70)	40	0.925*
Coffee milk	13 (31)	29 (69)	42	

*significant if p<0.05
Source: primary data

and changes in body fat composition.

From this study, it was found that there was no difference between milk coffee and black coffee on the incidence of prediabetes in obese patients. This finding indicates that coffee type may not play a major role in glucose metabolism within this population. Previous studies have reported that coffee consumption exerts a protective effect against type 2 diabetes mellitus, primarily due to its bioactive compounds with antioxidant and anti-inflammatory properties (Carlström & Larsson, 2018). However, a study conducted in Vietnam demonstrated contrasting results, possibly because the potential protective effects of coffee may only become evident at higher consumption levels than those observed in the present study. The Vietnamese coffee cup used as a reference (65 mL/cup) is considerably smaller than a typical coffee cup (150–250 mL/cup), suggesting that the actual coffee intake may have been lower compared with studies reporting significant effects (Fukunaga *et al*., 2024). A study investigating the association between coffee type and insulin resistance reported that, among women, higher consumption of black coffee was significantly associated with lower odds of elevated HOMA-IR and fasting insulin levels (p for trend ≤ 0.02). In contrast, no significant associations were observed among men or individuals who consumed coffee with added sugar and/or cream. These findings suggest that the beneficial metabolic effects of coffee may depend on both sex and coffee preparation type. In particular, consuming two or more cups of black coffee per day appears to be inversely associated with insulin resistance among Korean women, highlighting the potential role of unsweetened coffee in improving insulin sensitivity (Choi *et al*., 2025).

In the present study, neither type of coffee examined accounted for the sugar content added during preparation. This limitation likely explains the absence of significant differences between the groups, indicating that sugar content may have a greater influence on prediabetes risk than coffee type itself. Therefore, further studies are needed to investigate the effects of specific coffee types while carefully controlling sugar content and other additives. Theoretically, excessive sugar intake leads to insulin resistance, which subsequently progresses to prediabetes and type 2 diabetes mellitus. Prediabetes is characterized by elevated plasma insulin levels (hyperinsulinemia) as a compensatory response of pancreatic β-cells to increasing insulin resistance. Several factors that worsen insulin resistance include obesity, inflammation, mitochondrial dysfunction, hyperinsulinemia, lipotoxicity, hyperlipidemia, genetic factors, endoplasmic reticulum (ER) stress, aging, oxidative stress, fatty liver, hypoxia, lipodystrophy, and pregnancy (Sri & Mumtaz, 2024; Yaribeygi *et al*., 2021). Other studies have stated several possible factors causing prediabetes, such as hypertension, which can affect heart health and morbidity, obesity, alcohol consumption, and age ≥ 40 years. This prediabetes condition is reversible, meaning it can still return to normal if it is managed properly. The management principle is with a calorie deficit/balanced nutritional diet, regular exercise/physical activity, and pharmacology such as metformin (Galaviz *et al*., 2022; Langingi *et al*., 2025).

Coffee consumed with additives such as milk, creamer, or sweetened condensed milk tends to contain higher calories compared with black coffee without any additives. Excess

calorie intake may contribute to weight gain and, over time, lead to obesity. Obesity itself is strongly associated with various metabolic complications, including prediabetes and hypertension (Ikhlasia *et al.*, 2025). Recent discussion suggests that abdominal obesity in adolescents is related to childhood obesity, as well as excess calorie intake in childhood (Moelyo *et al.*, 2025). However, in the present study, no significant difference was found between black coffee and milk coffee in relation to the incidence of prediabetes. This result may be explained by several factors. First, some participants who reported drinking black coffee also consumed it with added sugar, thereby minimizing the expected difference between the two groups. Second, the study population was predominantly composed of young adults, who generally have better glucose homeostasis. This is supported by the finding that only about 30% of participants were classified as prediabetic. In addition, other factors such as overall dietary patterns, physical activity levels, and psychological stress may have influenced the development of prediabetes and should be considered in future analyses. A major limitation of this study is its cross-sectional design, which precludes establishing a causal relationship between coffee type and prediabetes. Therefore, further experimental or longitudinal studies are needed to confirm the potential influence of coffee type on prediabetes and to better control for confounding factors.

Conclusions

In conclusion, both black coffee and milk coffee consumption showed no significant effect on fat mass and prediabetes among obese adults. These findings indicate that the type of coffee consumed—whether black coffee or coffee mixed with milk—may not serve as a major determinant of metabolic outcomes in this population. Although milk coffee generally contains additional calories from milk or sweeteners, its consumption did not demonstrate a measurable difference in glucose metabolism or body fat composition compared to black coffee in this study. This suggests that other factors, such as total energy intake, dietary patterns, physical activity, and genetic predisposition, may play a more substantial role in influencing metabolic risk among individuals with obesity. Further research with a larger, more diverse sample size and a longitudinal design is recommended to clarify the long-term metabolic effects of various coffee preparations and their interaction with lifestyle and nutritional factors.

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