



Cross-sectional Study of Factors Affecting Prediabetes Risk Among Adults in Medan, Indonesia

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Article details:

Published: 30th June 2025



Abstract

Diabetes mellitus is a non-communicable disease whose mortality rate continues to increase every year. One condition that needs attention is prediabetes, known to be the phase before the onset of diabetes. Early detection and control of prediabetes risk factors are crucial to prevent the development of diabetes mellitus in the future. This study aims to identify the factors affecting prediabetes risk among adults.

This cross-sectional study was conducted in seven community health centers located in seven subdistricts in Medan, Indonesia. A sample of 270 respondents was selected through purposive sampling, and data analysis was conducted using logistic regression. The research results suggest that the factors that significantly affect the risk of prediabetes include body mass index (Exp (B): 1.826 (1.038-3.212); $p=0.037$), consumption of sweet foods and beverages (Exp (B): 1.834 (1.030-3.266); $p=0.039$), a sedentary lifestyle (Exp (B): 2.328 (1.332-4.067); $p=0.003$), and hypertension (Exp (B): 1.773 (1.042-3.017); $p=0.035$). A sedentary lifestyle is the most dominant predictor of prediabetes (Exp (B): 2.328 (1.332-4.067); $p=0.003$) among adults in Medan. Community health centers are expected to optimize non-communicable disease prevention programs to detect prediabetes early, identify risk factors, and provide education to the community to prevent its progression into diabetes mellitus.

Keywords: Adults, Cross-sectional, Diabetes mellitus, Prediabetes, Risk

To cite this article :

Dessy Sihite, Rahayu Lubis, E. S. (2025). Cross-sectional Study of Factors Affecting Prediabetes Risk Among Adults in Medan, Indonesia. *International Journal of Health, Education and Social (IJHES)*, 8(6), 136–145.



Introduction

Currently, non-communicable diseases are the leading cause of death worldwide. Non-communicable diseases caused at least 43 million deaths in 2021, equivalent to three-quarters (75%) of total non-pandemic-related deaths globally. Non-communicable diseases are not only prevalent among the elderly but now threaten the productive age group. Approximately 18 million people died from non-communicable diseases before the age of 70, and 82% of these premature deaths occurred in low- and middle-income countries. The four non-communicable diseases—cardiovascular disease (19 million), cancer (10 million), chronic respiratory disease (4 million), and diabetes mellitus (>2 million, including deaths from kidney failure caused by diabetes)—account for 80% of all premature deaths due to non-communicable diseases (WHO, 2024b).

Diabetes mellitus (DM) is a non-communicable disease with mortality rates that continue to rise each year. According to data from the International Diabetes Federation (2021), globally, 537 million adults aged 20–79 years (10.5%) are living with diabetes, and this number is projected to reach 643 million (11.3%) by 2030. Meanwhile, in 2022, 14% of adults aged 18 and older were reported to be living with diabetes, an increase of 7% compared to 1990 (WHO, 2024a). Diabetes mellitus caused 6.7 million deaths in the 20–79 age group in 2021, and 47% of all deaths from diabetes occurred before the age of 70 (IDF, 2021). Indonesia was the fifth country with the highest number of diabetes cases in 2021, with 19.5 million cases. The prevalence of diabetes based on doctor diagnosis in individuals aged ≥ 15 years increased to 2.2% in 2023 from 2.0% in 2018. Based on blood glucose level tests, the prevalence of diabetes also increased from 8.5% in 2018 (Kemenkes RI, 2019) to 11.7% in 2023 (Kemenkes RI, 2023).

Diabetes mellitus, especially type 2, the most common type among adults, has been shown to cause complications and even death, which can reduce productivity, human resource quality, and life expectancy. Therefore, controlling risk factors, screening, and early detection are necessary to reduce the incidence of type 2 diabetes. One condition that requires attention is prediabetes, which is the phase before the onset of diabetes, manifesting as impaired fasting blood glucose and/or impaired glucose tolerance. The criteria for prediabetes include fasting plasma glucose levels of 100–125 mg/dl and/or plasma glucose levels 2 hours after an oral glucose tolerance test (75-gram glucose load) of 140–199 mg/dl, or HbA1c levels of 5.7–6.4% (ADA, 2022). In 2021, an estimated 541 million adults (10.6%) were reported to have impaired glucose tolerance, while 319 million adults (6.2%) worldwide were reported to have impaired fasting glucose (IDF, 2021). Meanwhile, in Indonesia, the prevalence of impaired fasting glucose and impaired glucose tolerance among individuals aged ≥ 15 years was found to be quite high, at 13.4% and 18.6%, respectively, in 2023 (Kemenkes RI, 2023).

Besides being caused by unmodifiable risk factors (age, gender, race/ethnicity, and genetics), the high burden of noncommunicable diseases, including diabetes mellitus and prediabetes, is also thought to be influenced by various modifiable risk factors, mainly due to advances in technology and economic, social, and cultural shifts that have led to changes in people's behavior and lifestyle, including lack of physical activity, unhealthy eating habits, smoking habits, and alcohol consumption. Previous studies have found that individuals with better



nutritional status and those who exercise less than three days per week have a 2.4-fold and 4-fold higher risk of developing prediabetes, respectively (Sovia et al., 2020). Unhealthy eating patterns and smoking habits also influence the occurrence of prediabetes and increase the risk by more than twofold (Sukenty et al., 2018). A previous study based on the 2013 Indonesian Basic Health Research Analysis also showed that age (>30 years), being female, and consuming high-fat foods (>1 time per day) are significantly associated as determinants of impaired glucose tolerance incidence, while impaired fasting glucose is associated with age (>40 years) and consuming sweet foods (>1 time per day). Meanwhile, the most dominant risk factors for both impaired fasting glucose and impaired glucose tolerance conditions are age (≥ 45 years) and obesity (Dany et al., 2017).

Prediabetes is a risk factor for the development of type 2 DM in the future, and individuals with prediabetes have the same risk of complications as those with diabetes. The cumulative incidence of type 2 DM development after five years of diagnosis with impaired glucose tolerance and impaired fasting glucose is estimated to be 26% and 50%, respectively (IDF, 2021). In a systematic review of cohort studies, individuals with prediabetes and HbA1c levels of 6.0–6.5% have a risk of up to 25–50% (within five years) and a relative risk 20 times higher than individuals with normal HbA1c levels for developing diabetes mellitus (ADA, 2022). However, research also shows that 55–80% of individuals with impaired fasting glucose can return to normoglycemia after 10 years of follow-up. A reduction in the relative risk of developing diabetes among prediabetes patients by 40–70% is also observed after lifestyle intervention (Tabák et al., 2012). This highlights the importance of early detection of prediabetes in preventing the onset and complications of diabetes mellitus.

North Sumatra Province is a province in Indonesia that has also shown an increase in the number of diabetes patients, from 225,587 patients in 2022 (Dinkes Provinsi Sumatera Utara, 2022) to 228,551 patients in 2023 (Dinkes Provinsi Sumatera Utara, 2023). In Medan, the percentage of diabetes mellitus patients also increased significantly, from 12,614 patients in 2022 (Dinkes Kota Medan, 2022) to 42,380 patients in 2023 (Dinkes Kota Medan, 2024). The high cases of diabetes mellitus and the lack of available prediabetes data led to this study that aims to identify prediabetes prevalence among adults in the city of Medan and the factors contributing to it as part of an approach to early detection of prediabetes. This is aimed at controlling risk factors to prevent progression to type 2 diabetes mellitus, thereby reducing the prevalence of diabetes mellitus in the city of Medan.

Methods

The type of research used was observational analytical with a cross-sectional design. The study was conducted from August 2024 to May 2025 in Medan. The sample size was determined using Isaac and Michael's table with a 10% margin of error, resulting in a sample of 270 respondents. The sample was taken from seven community health centers located in seven subdistricts that were randomly selected to represent the 21 subdistricts in Medan, and the number was divided proportionally from the total sample. The sample was selected using purposive



sampling, with inclusion criteria: individuals aged 18–35 years, not diagnosed with type 2 diabetes, without endocrine or metabolic disorders affecting glucose levels, and not pregnant or breastfeeding (for female respondents), and exclusion criteria: individuals with severe psychological disorders or mental disorders and those having difficulty communicating.

The variables in this study consist of dependent variables and independent variables. The dependent variable is a prediabetes condition, while the independent variables are respondent characteristics, such as gender, age, marital status, education, occupation, income, body mass index (BMI), family history of diabetes mellitus, and hypertension, along with lifestyle factors, including alcohol consumption, smoking, consumption of sweet foods and beverages, consumption of vegetables and fruits, physical activity, and sedentary lifestyle. Data collection was conducted through interviews using a questionnaire. The collected data were further analyzed using logistic regression analysis. The confidence level of the statistical test used in this study was 95%, or significant if $p < 0.05$.

Results

The results of the study based on data collected from 270 adults in Medan are presented below.

Table 1. Results of Simple Logistic Regression Analysis

Variables	Prediabetes				Total n=270		Exp (B) (95% CI)	p
	Not prediabetes		Prediabetes					
	n	%	n	%				
Gender								
Male	34	27.2	91	72.8	125	100	0.858	0.570
Female	44	30.3	101	69.7	145	100	(0.505-1.457)	
Age								
≤26 years	38	27.3	101	72.7	139	100	0.856	0.563
>26 years	40	30.5	91	69.5	131	100	(0.505-1.449)	
Marital status								
Not married	36	34.3	69	65.7	105	100	1.528	0.120
Married	42	25.5	123	74.5	165	100	(0.896-2.606)	
Education								
High	74	29.4	178	70.6	252	100	1.455	0.520
Low	4	22.2	14	77.8	18	100	(0.464-4.567)	
Employment								
Employed	76	30.3	175	69.7	251	100	3.691	0.086
Not employed	2	10.5	17	89.5	19	100	(0.832-16.374)	
Income								
High	37	33.0	75	67.0	112	100	1.408	0.206
Low	41	25.9	117	74.1	158	100	(0.828-2.393)	
Body mass index (BMI)								



Normal	29	38.2	47	61.8	76	100	1.826	0.037*
At risk (>25 kg/m ²)	49	25.3	145	74.7	194	100	(1.038-3.212)	
Family history of DM								
Absent	58	27.5	153	72.5	211	100	0.739	0.338
Present	20	33.9	39	66.1	59	100	(0.398-1.371)	
Alcohol consumption								
No	68	30.1	158	69.9	226	100	1.463	0.326
Yes	10	22.7	34	77.3	44	100	(0.684-3.130)	
Smoking								
No	52	32.7	107	67.3	159	100	1.589	0.099
Yes	26	23.4	85	76.6	111	100	(0.916-2.754)	
Consumption of sweet foods and beverages								
Not at risk	27	38.6	43	61.4	70	100	1.834	0.039*
At risk	51	25.5	149	74.5	200	100	(1.030-3.266)	
Vegetables and fruits consumption								
Sufficient	40	34.8	75	65.2	115	100	1.642	0.067
Insufficient	38	24.5	117	75.5	155	100	(0.966-2.791)	
Physical activity								
Sufficient	17	21.0	64	79.0	81	100	0.557	0.063
Insufficient	61	32.3	128	67.7	189	100	(0.301-1.032)	
Sedentary lifestyle								
Low	33	41.8	46	58.2	79	100	2.328	0.003*
High	45	23.6	146	76.4	191	100	(1.332-4.067)	
Hypertension								
Not hypertension	44	35.2	81	64.8	125	100	1.773	0.035*
Hypertension	34	23.4	111	76.6	145	100	(1.042-3.017)	

*p<0.05

Table 1 shows that the factors significantly affecting prediabetes among adults in Medan are body mass index (p=0.037), consumption of sweet foods and beverages (p=0.039), sedentary lifestyle (p=0.003), and hypertension (p=0.035). The study results indicate that adults with a BMI >25 kg/m² have a 1.826 times (95% CI: 1.038–3.212) higher risk of having prediabetes compared to adults with a normal BMI. Adults who consume sweet foods and beverages and have a sedentary lifestyle were also found to have a 1.834 (95% CI: 1.030–3.266) times higher risk and a 2.328 (95% CI: 1.332–4.067) times higher risk of having prediabetes, respectively, compared to those who do not consume sweet foods and beverages and have a less sedentary lifestyle. Based on the study results, it was also found that adults with hypertension had a 1.773 (95% CI: 1.042–3.017) higher risk of having prediabetes compared to those without hypertension.

Table 2. Multivariate Logistic Regression Analysis Results

Variable	B	p	Exp (B)	95% CI
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					<i>Lower</i>	<i>Upper</i>
Step 1 ^a	Sedentary lifestyle	0.845	0.003	2.328	1.332	4.067
	<i>Constant</i>	-0.513	0.293	0.599		
Step 2 ^b	Body mass index	0.594	0.043	1.812	1.019	3.220
	Sedentary lifestyle	0.839	0.003	2.315	1.318	4.065
	<i>Constant</i>	-1.510	0.031	0.221		

Based on the results of multiple logistic regression analysis, it was found that a sedentary lifestyle was the strongest predictor of prediabetes ($p=0.003$). Adults with a high sedentary lifestyle had a 2.328 times greater risk of developing prediabetes than adults with a low sedentary lifestyle.

Discussion

The results of the study show that age and gender do not significantly affect prediabetes. A study conducted by Maghfiroh et al. (2024) also found that young adults (aged 25–39 years) are not at increased risk of prediabetes, while middle-aged adults (40–59 years) have a 1.3 times higher risk of developing prediabetes compared to older adults (≥ 60 years). Meanwhile, Pratiwi et al. (2024) in their study explained that the risk of prediabetes increases higher in adults over 40 years old and rises with age. This is associated with the decline in the function of most body organs as age increases, including the pancreas, which produces insulin, leading to elevated blood sugar levels. Differences in the risk of prediabetes incidence between men and women were also reported inconsistently in the studies. A study conducted by Fadzilah Fairuz et al. (2020) did not find any effect of gender on the of prediabetes. On the other hand, a study by Hormenu et al. (2024) showed that the prevalence of prediabetes is higher in women than in men, but conversely, a study conducted by Ismail et al. (2023) suggested that men are at higher risk of developing prediabetes than women. This indicates that other factors such as behavior and lifestyle may indirectly influence the differences in prediabetes risk based on gender. Marital status was also found to have no association with prediabetes. These results align with previous research by LIMA et al. (2022), which found no difference in prediabetes risk between married and unmarried adults.

Several studies have linked socioeconomic factors to the incidence of prediabetes, although the observed associations are inconsistent. Individuals with higher socioeconomic status, such as higher education levels, employment, and higher income, are believed to have a greater ability to control blood sugar levels, thereby preventing the development of prediabetes. However, the results of this study indicate that education, employment, and income do not significantly affect prediabetes risk. This aligns with a study conducted by K. S. et al. (2024), which also showed that the risk of prediabetes does not vary based on socioeconomic status, indicating that other factors, such as behavior or lifestyle, may influence the risk of prediabetes. The results of this study also indicate that a family history of diabetes does not significantly affect the risk of prediabetes. This finding is consistent with a study by Phan et al. (2022), which found no significant association between a family history of DM and the prediabetes prevalence.



Based on the findings of this study, it is also known that body mass index (BMI) is associated with prediabetes. A previous study by He et al. (2021) also found that a BMI >25 kg/m² is significantly associated with the incidence of prediabetes in both men and women. Body mass index is used to determine obesity, a condition that has been strongly linked to the development of insulin resistance, which can increase the risk of prediabetes and diabetes. Conversely, the study results indicate that alcohol consumption and smoking do not affect the incidence of prediabetes. This is supported by research by Sengupta & Bhattacharjya (2020), which showed that smoking and alcohol consumption habits have no effect on the incidence of prediabetes. Smoking has been associated with glucose metabolism and the development of insulin resistance and pancreatic beta cell dysfunction, thereby potentially increasing the risk of prediabetes, while excessive alcohol consumption has been proven to have adverse effects on body metabolism and increase the risk of various diseases. In this study, most adults did not drink alcohol; therefore, no difference in the risk of prediabetes incidence could be observed. Additionally, although a higher proportion of adults who smoked had prediabetes (76.6%), this factor was not found to significantly affect the incidence of prediabetes.

Consumption patterns have also been widely linked to the risk of prediabetes and the development of diabetes. Based on research findings, the consumption of sweet foods and beverages has a significant effect on prediabetes. Sugar is a simple carbohydrate that provides energy for the body, but excessive consumption can have serious health consequences, including the development of prediabetes and diabetes mellitus. In a study conducted by Moon et al. (2022), individuals who consumed sweetened foods and beverages more than two servings per day had a higher risk of developing prediabetes. Conversely, consumption of fruits and vegetables was found to have no effect on the risk of prediabetes. Consumption of vegetables and fruits is considered to be beneficial in preventing various chronic diseases due to their health-promoting nutrients. Most adults in this study had insufficient vegetable and fruit consumption, resulting in no difference in vegetable and fruit consumption between individuals with prediabetes and those without, indicating that vegetable and fruit consumption does not significantly affect the risk of prediabetes. Amelia et al. (2024) also reported in their study that there was no difference in the risk of prediabetes between individuals with and without daily consumption of fruits and vegetables.

Based on research findings, a sedentary lifestyle is also identified as the strongest predictor of prediabetes. A sedentary lifestyle refers to a person's lack of physical activity or movement. This imbalance between energy intake and expenditure can lead to obesity, further increasing the risk of prediabetes and diabetes. This is supported by the study by Ambarita et al. (2022), finding that sedentary behavior characterized by higher durations of gadget use and sitting compared to higher physical activity is significantly positively correlated with the incidence of prediabetes. Amelia et al. (2024) also explained in their study that physical activity significantly influences the prevalence of prediabetes, as individuals who never engage in physical activity have a 1.6 times higher risk of developing prediabetes compared to those who engage in physical activity for at least 30 minutes per day. Conversely, the results of this study indicate that physical activity does not significantly affect the risk of prediabetes. This is likely due to the low level of physical activity



among both prediabetic and non-prediabetic individuals, showing no difference in risk between the two groups.

Another finding of this study suggests that hypertension significantly affects the risk of prediabetes. Previous studies have shown that patients with untreated hypertension have higher fasting and postprandial insulin levels compared to normotensive individuals. On the other hand, elevated fasting plasma glucose levels have also been associated with arterial stiffness, potentially mediated through oxidative stress mechanisms and changes in vasoactive substance activity. In diabetic patients, vascular wall integrity is more susceptible to damage, thereby increasing the risk of hypertension and cardiovascular disease. Ismail et al. (2023) found in their study that hypertension significantly influences the risk of prediabetes. These findings are consistent with a previous study by Phan et al. (2022), which showed that individuals with hypertension have a 1.3 times higher risk of developing prediabetes compared to normotensive individuals.

Conclusion and Recommendation

Body mass index, consumption of sweet foods and beverages, sedentary lifestyle, and hypertension are factors that significantly affect the risk of prediabetes among adults in Medan. Sedentary lifestyle is the strongest predictor of prediabetes among adults. Community health centers and healthcare workers are encouraged to optimize non-communicable disease prevention programs, such as Posyandu and chronic disease management programs (Prolanis), to conduct routine health checkups for the community to detect prediabetes, identify risk factors, and provide education on factors that can increase the incidence of prediabetes so that the community can take preventive measures independently.

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