



Original

An Overview of the Frequency Distribution of the Prediabetes Population: Identified by a FINDRISC Survey in Semarang City

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ABSTRACT

Background: It is important to collect data as an initial screening for prediabetes in an early effort to control diabetes. This study aims to determine the frequency distribution of prediabetes among the population in Semarang City.

Method: This research method is descriptive quantitative with a cross-sectional approach. The research instrument used was the Finnish Diabetes Risk Score (FINDRISC). The sample size was 246, conducted from August 16 to November 4, 2023, in Semarang City.

Result: Most residents of Semarang City are at low risk (67.9%) of developing diabetes mellitus within 10 years; however, some respondents are at slightly high risk (19.9%), moderate risk (11.0%), and high risk (1.2%) of developing diabetes within 10 years. This condition can be influenced by the current health condition of the respondents, which shows that most respondents have a body mass index and waist circumference of more than the normal values. Through statistical tests, it was shown that body mass index, waist circumference in women, current blood sugar, family history of diabetes, and consumption of hypertension drugs were associated with an increased risk of diabetes with a p-value <0.05. On the other hand, consumption of fruits and vegetables was not statistically related, p-value >0.05.

Conclusion: Most residents of Semarang City are at low risk of developing diabetes mellitus; however, a proportion of respondents fall into slightly high to high-risk categories. Promotive and preventive interventions to control prediabetes and reduce the progression to diabetes are needed.

Keywords: Blood sugar, prediabetes, prevalence



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INTRODUCTION

Prediabetes is a transitional condition of blood sugar levels from normal to diabetic conditions.¹ Based on the American Diabetes Association (ADA), there are two criteria for diagnosing prediabetes: the first criterion is said to be Impaired Glucose Tolerance (IGT) if the results of the oral glucose tolerance test are 140-199 mg/dL and the results of the fasting blood glucose test are <126 mg/dL. The second criterion is Impaired Fasting Glucose (IFG) if the oral glucose tolerance test result is <140 mg/dL and the fasting blood sugar test result is 100-125.²

The global prevalence in 2021 showed that 464 million (9.1%) had impaired glucose tolerance and is expected to increase to 638 million (10%) by 2045. A total of 298 million (5.8%) of the adult population (20-79 years) globally has impaired fasting glucose and is expected to continue to increase to 414 million (6.5%) by 2045.^{3,4} Conditions in Indonesia itself show that in 2019, Indonesia ranked third in the world with the most people with impaired glucose tolerance, namely 29.1 million people.³ Research in the United States has shown that every year, as many as 10% of people with prediabetes develop diabetes. The results of other studies show that there is disease progression from prediabetes to type 2 diabetes in 25% of individuals within 3-5 years.^{3,5}

Prediabetes is a risk factor for diabetes mellitus. The development of prediabetes into diabetes mellitus can be influenced by genetics, physical conditions, and the social environment.⁶ Prediabetes is one of the diseases that needs to be controlled. Research results show that there is a relationship between prediabetes and the occurrence of various other serious diseases, such as heart failure, Parkinson's disease, cardiovascular disease, coronary heart disease, stroke, chronic kidney disease, and death.^{1,7-9} The results of previous research conducted in Saudi Arabia stated that only 27% of respondents knew the risk factors for prediabetes.¹⁰ The results of other studies also show that the level of awareness, control, and treatment of diabetes in China is low.^{11,12} This condition is one of the reasons why prediabetes and diabetes cases increase every year.

The increase in the prevalence of diabetes every year requires special action and attention. The first step that can be taken is early detection of diabetes and prediabetes in risk groups to inhibit the development of diabetes. This study aims to determine the frequency distribution of prediabetes among the population in Semarang City, Indonesia.

METHODS

Study design: This study employed a descriptive quantitative cross-sectional design. The study was conducted in Semarang City from August 16 to November 4, 2023.

Sample and sampling technique: The sample size calculated using the Lemeshow formula was 246 respondents. Cluster random sampling was used. Inclusion criteria were domiciled in Semarang City. Exclusion criteria included inability to undergo anthropometric measurements due to illness or physical weakness.

Research instrument: Each respondent was assessed once using the Finnish Diabetes Risk Score (FINDRISC) questionnaire. The FINDRISC instrument was used due to its validated and reliable ability to predict diabetes risk within 10 years.¹³

Statistical analysis: Data were analyzed using univariate and bivariate analysis. The data were grouped into 3 data groups, namely demographic data, FINDRISC instrument data, and the final data of the risk category group, presented in a frequency distribution table. Furthermore, the correlation between variables tested by chi-square analysis.

RESULTS

Demographic Characteristic

The demographic characteristics of respondents, including gender and occupation, are shown in **Table 1**.

Table 1. Characteristic Demographic of respondents (n=246)

Characteristics	n (%)
Gender	
Male	31 (12.6%)
Female	215 (87.4%)
Occupation	
Labor	3 (1.2%)
Driver	1 (0.4 %)
Housewife	133 (54.1%)
Employee	16 (6.5%)
Student	3 (1.2%)
Health worker	25 (10.2%)
Government employees	21 (8.5%)
Privat sector	35 (14.2%)
Self-employed	9 (3.7%)

The results of the study related to demographic data showed that all respondents were aged 26-35 years. Most respondents were female (87.4%), and over half were housewives (54.1%).

Characteristic of respondents

The characteristics of respondents based on FINDRISC, including age, body mass index, waist circumference, physical activity, consumption of vegetables or fruits, consumption of hypertension drugs, current blood sugar, and family history of diabetes, are shown in **Table 2**.

Table 2. Overview of respondent characteristics

Characteristic of respondents	Point	Total n(%)	Diabetes Risk Levels by FINDRISC Scores n(%)			
			Low risk	moderately high risk	Medium risk	High risk
Age (years)		30±3.19	30±3.027	30±3.278	30±3.689	34±1.155
<45	0	246 (100%)	136 (100%)	80 (100%)	27 (100%)	3 (100%)
45-54	2	0	0	0	0	0
55-64	3	0	0	0	0	0
>64	4	0	0	0	0	0
Body Mass Index		25.44±4.85	22.38±3.11	28.70±3.61	30.92±4.23	27.59±2.90
<23	0	78 (31.7%)	75 (55.1%)	3 (3.8%)	27 (100)	0
23-25	1	46 (18,7%)	41 (30,1%)	4 (5,0%)	0 (0%)	1 (33,3%)
>25	3	122 (49,6%)	20 (14,8%)	73 (91,2%)	0 (0%)	2 (66,7%)
Waist circumference (cm)						
Male						
<90	0	19 (61.3%)	16 (80.0%)	1 (14.3%)	1 (25%)	0 (0%)
90-98	3	10 (32.3%)	4 (20.0%)	5 (71.4%)	2 (50%)	0 (0%)
>98	4	2 (6.4%)	0 (0%)	1 (14.3%)	1 (25%)	0 (0%)
Female						
<80	0	74 (34.4%)	71 (61.2%)	2 (2.7%)	1 (4.3%)	0 (0%)
80-88	3	68 (31.6%)	42 (36.2%)	23 (31.5%)	1 (4.3%)	2 (66.7%)
>88	4	73 (34.0%)	3 (2.6%)	48 (65.8%)	21 (91.4%)	1 (33.3%)
Physical activity						
Yes	0	246 (100%)	136 (100%)	80 (100%)	27 (100%)	3 (100%)
No	2	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Consumption of fruits and vegetables						
Everyday	0	148 (60.2%)	81 (59.6%)	47 (58.8%)	19 (70.4%)	1 (33.3%)
Not everyday	1	98 (39.8%)	55 (40.4%)	33 (41.2%)	8 (29.6%)	2 (66.7%)
Consumption of hypertension drugs						
No	0	229 (93.1%)	132 (97.1%)	70 (87.5%)	25 (92.6%)	2 (66.7%)
Yes	2	17 (6.9%)	4 (2.9%)	10 (12.5%)	2 (7.4%)	1 (33.3%)
Current blood sugar (mg/dl)		108.5±30.24	103.6 ± 19.18	109.04±22.37	114.0±37.7	268±93.69
No (<200 mg/dl)	0	241 (98%)	136 (100%)	79 (98.8%)	25 (92.6%)	1 (33.3%)
Yes (>200 mg/dl)	2	5 (2%)	0 (0%)	1 (1.2%)	2 (7.4%)	2 (66.7%)
Family history of diabetes						
No	0	162 (65.9%)	111 (81.6%)	51 (63.7%)	0 (0%)	0 (0%)
Yes: grandfather, aunt, uncle, or first cousin (but not parent, brother, sister, or child)	3	30 (12.1%)	11 (8.1%)	16 (20.0%)	3 (11.1%)	0 (0%)
Yes: parent, brother, sister, or own child	5	54 (22.0%)	14 (10.3%)	13 (16.3%)	24 (88.9%)	3 (100%)

The results of the study related to physical examination showed that the prevalence of BMI >25 kg/m² was 49.6%. The prevalence of increased waist circumference (>90 cm in men and >80 cm in women) was 38.7% and 65.6%, respectively. The results showed that at least 34.1% of respondents had a history of diabetes, and 2% of respondents were found to have a blood sugar level >200 mg/dl. This may be due to the fact that 39.8% of respondents did not consume fruits or vegetables daily.

Frequency distribution of prediabetes

Risk categories based on FINDRISC are divided into 5 risk groups: low risk, moderately high risk, medium risk, high risk, and very high risk. The number of respondents at each risk is shown in **Table 3**.

Table 3. Frequency distribution of prediabetes in Semarang City

Categories	Point	n (%)
Low risk	<7	136 (67.9%)
Moderately high risk	7-11	27 (11.0%)
Medium risk	12-14	80 (19.9%)
High risk	15-20	3 (1.2%)
Very high risk	>20	0 (0%)
Total		246 (100%)

The results showed that 67.9% of respondents were at low risk of developing diabetes mellitus within 10 years; however, some respondents were at slightly high risk (19.9%), moderate risk (11.0%), and high risk (1.2%) of developing diabetes within 10 years.

The following is a statistical test to see the variables related to the risk of diabetes in the future in respondents using the FINDRICS survey presented in **Table 4**.

Table 4. Relationship between body mass index, waist circumference, current blood sugar, family history of diabetes, consumption of fruits and vegetables, and consumption of hypertension drugs with diabetes risk levels

Variables	Diabetes Risk Levels by FINDRISC Scores				p-value
	Low risk	moderately high risk	Medium risk	High risk	
Body Mass Index					0,000
<23	75	3	0	0	
23-25	42	3	0	1	
>25	50	43	27	2	
Waist circumference (cm)					
Male	23	4	4	0	0,058
<90	17	1	1	0	
90-98	6	2	2	0	
>98	0	1	1	0	
Female					0,000
<80	71	2	1	0	
80-88	50	15	1	2	
>88	23	28	21	1	
Current blood sugar (mg/dl)					0,000
Tidak (GDS<200)	167	48	25	1	
Ya (GDS>200)	0	1	2	2	
Family history of diabetes					0,000
No	142	20	0	0	
Yes: grandfather, aunt, uncle, or first cousin (but not parent, brother, sister, or child)	11	16	3	0	
Yes: parent, brother, sister, or own child	14	13	24	3	
Consumption of fruits and vegetables					0,457
Everyday	101	27	19	1	
Not everyday	66	22	8	2	
Consumption of hypertension drugs					0,001
No	162	40	25	2	
Yes	5	9	2	1	

Through statistical tested, it was shown that body mass index, waist circumference in women, current blood sugar, family history of diabetes, and consumption of hypertension drugs were associated with an increased risk of diabetes with a p-value <0.05. On the other hand, consumption of fruits and vegetables was not statistically related p-value >0.05.

DISCUSSION

The findings showed that most respondents were at low risk of developing type 2 diabetes within 10 years (67.9%). Global data indicate an increasing prevalence of prediabetes. A total of 9.1%, or about 464 million people, have prediabetes, and it is expected to increase to 10%, or about 638 million people with prediabetes, by 2045.^{1,14,15} The increase in prediabetes cases globally is also influenced by the increase in cases in several countries. The results of research in Swat, Pakistan, show that one in 5 residents has prediabetes.¹⁶ Indonesia itself, in 2019, ranked third in the world with the largest population experiencing impaired glucose tolerance, namely 29.1 million people.^{16–18}

The rising incidence of prediabetes and diabetes highlights the need for evaluation, especially related to the lifestyle that each person lives. The results of the research that has been done show that there are several characteristics of respondents who are at risk of developing diabetes. Lifestyle modification and nutritional patterns are fundamental in prediabetes cases.^{1,9,19,20} The progression of prediabetes to diabetes will take about 9–12 years.^{21,22} The results of observational studies show that prediabetes and diabetes will develop faster, especially in individuals who are genetically susceptible and have more weight.^{23,24}

The first risk factor for prediabetes is gender. The majority of respondents involved in this study were female. The results of other studies show that females are at a higher risk of prediabetes than males.²⁵ This may be influenced by hormonal factors affecting glucose metabolism, which can lead to disturbances in glucose and lipids, regulation of energy balance, body fat distribution, and cardiovascular disease.^{26,27} The second risk factor for prediabetes is body mass index. The results showed that most respondents had an abnormal body mass index, namely, as many as 49.6% of respondents had a body mass index >25 kg/m², and as many as 31.7% of respondents had a body mass index <23 kg/m². Obese individuals are approximately 2.5 times more likely to develop prediabetes compared to people who are not obese.^{28–30} The results of another study conducted in Kuwait showed that the prevalence of prediabetes in obese people was higher than in people who were not obese.³

Several other studies have shown that there is an association between obesity. The link between obesity and type 2 diabetes occurs primarily through a complex series of mechanisms that affect the body's ability to manage blood sugar. Excess body fat, particularly

abdominal fat, plays a central role in this process. Abdominal fat, or visceral fat that surrounds internal organs, is more metabolically active than other types of fat. Fat cells in this area release various chemicals, including inflammatory substances called cytokines. These cytokines can interfere with the insulin signaling pathway in cells, worsening insulin resistance. Furthermore, cytokines can damage beta cells in the pancreas, the cells responsible for insulin production. This damage gradually reduces the pancreas' ability to produce sufficient insulin.^{31–33}

The results showed that most of the female respondents (65.6%) had a waist circumference greater than the normal value. Previous studies have shown that waist circumference is the biggest predictor of diabetes development in a population.^{32,34} An excessive waist circumference is one sign of metabolic syndrome. Metabolic syndrome is a combination of health conditions, including high blood pressure, high blood sugar, excess waist fat, and high cholesterol. This is why waist circumference influences the risk of future diabetes.^{35–37}

The next risk factor is a family history of diabetes. The results showed that 34.1% of respondents had a family history of diabetes. Although not the primary determinant, having genetic factors puts someone at higher risk of developing diabetes.²⁵ According to the American Diabetes Association, experts have found a link between genetic mutations and a higher risk. Not everyone with these genetic mutations will necessarily develop diabetes. However, it is undeniable that many people with one or more of these genetic mutations develop diabetes later in life. Some gene mutations that influence the risk of developing diabetes are genes that control blood sugar production, insulin production and regulation, and the detection of blood sugar levels in the body. Some genes associated with type 2 diabetes are TCF7L2 (a gene that influences insulin secretion and blood sugar production), ABCC8 (a gene that helps regulate insulin), CAPN10 (a gene associated with risk in certain races), GLUT2 (a gene that helps the process of blood sugar entry into the pancreas), and GCGR (a glucagon hormone that influences blood sugar regulation).^{26,27} Mutations in these genes can increase a person's risk of diabetes.³⁸

The results showed that all respondents reported engaging in at least 30 minutes of physical activity daily, there were still 49.6% of respondents who were obese. This condition could have been influenced because there were still 39.8% of respondents who did not consume

vegetables or fruit every day. The duration and quality of physical activity can also influence this condition. The results of other studies show that there is an influence of polyphenol interventions contained in fruits and vegetables on blood glucose in prediabetes and diabetes patients.^{39–41} Lifestyle can be said to be healthy if one is doing physical activity for at least 60 minutes per day with moderate to heavy intensity. A body mass index of more than normal can trigger prediabetes. The results of previous research show that a body mass index of more than normal values over a long period will cause prediabetes.^{21,31,42} Increased knowledge related to public health status also needs to be considered. The results of other studies state that there are still many people who do not know exactly what their health status is.^{43–45} From this study, it can be seen that it is necessary to emphasize health information to people with obesity, especially those with a family history of diabetes, to maintain a healthy lifestyle, because this factor has a strong relationship with the occurrence of diabetes in the future.

CONCLUSION

Based on the results of the study, it can be concluded that most respondents in this study were at low risk of developing type 2 diabetes within 10 years. The general characteristics of respondents in Semarang City included that all respondents were <45 years old and had at least 30 minutes of physical activity every day. The majority of respondents were female, worked as housewives, had an abnormal body mass index, had a blood sugar level <200 mg/dl, had no family history of diabetes, had a habit of consuming vegetables or fruit every day, and most had never taken hypertension medication continuously. The results of the waist circumference examination showed that most of the male respondents had waist circumference values in the normal range, while the female respondents mostly had waist circumference values above the normal values. There are age restrictions in the criteria of this study and the distribution of gender is uneven so that the generalization of this study is still weak and requires further research. The recommendation from this study is that increasing public self-awareness to routinely conduct health checks in at-risk groups needs to be done routinely to prevent diabetes in the future.

Declarations

Ethical Consideration:

This study was approved by the Health Research Ethics Committee, Universitas Muhammadiyah Semarang, with ethics number 173/KE/08/2023. After receiving an explanation of the study from the researchers and signing an informed consent, the participants were encouraged to participate. The data were coded anonymously for the questionnaire construction and data analysis. The participants were given the researchers' phone numbers and informed that they could withdraw from the study without facing any repercussions.

Author Contribution

SP is the principal Investigator, conceptualized the study, designed the methodology, coordinated the research process, conducted data analysis, drafted the initial manuscript, the literature review, reference management, and writing of the background and initial discussion sections, and performed the final revision of the article. SNC contributed to field data collection and assisted in the validation of research instruments, statistical analysis, data interpretation, and preparation of visual data representations. All authors have read and approved the final version of the manuscript for publication.

Conflict of interest

There is no conflict of interest in this study

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