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Central Obesity as A Risk Factor For Prediabetes

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KEYWORDS
central obesity; prediabetes; jati ranggon

ABSTRACT
Central obesity has become a health problem and is associated with the incidence of prediabetes. Prediabetes is characterized by impaired fasting blood glucose (GDPT) or impaired glucose tolerance (TGT) or both without any complaints and symptoms, and is a condition that precedes the occurrence of type 2 diabetes mellitus. This study aims to prove central obesity as a risk factor for prediabetes by calculating the prevalence ratio. The method of this research is observational analysis with a cross-sectional design approach. The respondents of the study were the community around the work area of the Jati Ranggon health center who met the inclusion and exclusion criteria, totaling 1241 people, 523 men and 718 women. The prevalence of central obesity in this study was 39.6%. The prevalence of prediabetes is 18.8%, prediabetes with central obesity is 27.9% and non-central obesity prediabetes is 12.8%. Bivariate analysis with chi-square showed a relationship between age and the incidence of prediabetes (RP=1.62, 95% CI 1.24-2.11 and p= <0.001), hypertension with the incidence of prediabetes (RP=1.58CI 95% 1.22-2.04, p=<0.001), gender with prediabetes (RP=1.47, 95% CI 1.12-1.94, and p=0.005), general obesity with prediabetes (RP=1.87, 95% CI 1.44-2.42 and p=<0.001), smoking with the incidence of prediabetes (RP= 0.54, 95% CI 0.33-0.88 and p=0.013). The results of multivariate analysis with cox regretion showed that the variables that affected prediabetes were central obesity (RP=1.87, CI95% 1.40-2.50, p=<0.001) and general obesity (RP=1.42, CI95% 1.06-1.89, p=0.017). Central obesity is a risk factor for prediabetes with a prevalence ratio of 2.18.

Introduction

Prediabetes is a condition in which blood sugar levels in a person's body are more than normal but have not been said to have diabetes / diabetes mellitus (DM). People with prediabetes have a higher risk of developing DM as well as DM-related complications, as well as an increased risk of cardiovascular diseases such as heart and stroke as well as microvascular. Prediabetes can be in the form of a disorder in fasting blood sugar levels called impaired fasting blood sugar (GDPT), a disorder in blood sugar levels 2 hours after a meal called impaired glucose tolerance (TGT), or a combination of both (Indonesia, 2015)

Based on the natural course of prediabetes, 25% will develop into type 2 DM within 10 (ten) years, 25% will become normal and 50% will remain in prediabetes within 2 (two) to 5 (five) years. In addition, the results of the Diabetes Prevention Program research also show that in the control group of research subjects who experience TGT with or without GDPT, 10% are DM.

Worldwide, there were 541 million (10.6%) adults with TGT in 2021, and it is expected to increase to 730 million (11.4%) by 2045. Those who experienced GDPT were 319 million (6.2%) in 2021 and are estimated to increase to 441 million (6.9%) in 2045. (IDF 2021).

Individuals with prediabetes are often found accidentally during a blood biochemical examination for DM. The progression of prediabetes to diabetes depends on the degree of insulin resistance and insulin secretion deficiency as well as risk factors for DM such as age, family history, overweight or obesity, Polycystic Ovary Syndrome (PCOS) and a history of gestational diabetes mellitus.

Based on the Ministry of Health of the Republic of Indonesia (2016), one of the risk factors for DM that cannot be modified is the age of ≥ 40 years. (Rudi & Kwureh, 2017) argues that with the increase in age, intolerance to glucose also increases. As for Indonesia, based on the results of Riskesdas 2018, the population aged 15 years and above who experienced TGT was 59 million (30.8%) while those who experienced GDPT were 50 million (26.3%).

Several studies conducted to evaluate several strategies for preventing prediabetes in the age of 45 and older in the United States show that screening and managing prediabetes cases is a good investment for public health. In this study, it was also said that fasting blood sugar (GDP) examination with oral glucose tolerance test (TTGO) is an effective strategy, but capillary blood sugar testing and the use of risk factor questionnaires are the most efficient. In addition, prediabetes screening for overweight or obese individuals can reduce costs compared to mass screening

Central obesity is a condition in which there is excess belly fat or central fat (Organization & Canada, 2015). It is said that central obesity is when the waist circumference (LP) > 90 cm in men and > 80 cm in women (WHO, 2023). Obesity is a risk factor between the occurrence of NCDs and ranks as the 5th highest risk factor for death (IHME 2017), Obesity also contributes 7.67% of the total DALYs in 2017, which was originally only 1.8% in 1990. The largest contribution of obesity as a risk factor occurred in heart disease (4.35% of total DALYs), diabetes and kidney disease (2.52% of total DALYs). Obesity as a risk factor contributes to the cause of death due to heart disease (5.87% of total deaths), diabetes and kidney disease (1.84% of total deaths).

Based on Riskesdas in 2013, the prevalence of central obesity nationally is 26.6%, an increase from 2007 of 18.8%. Indonesian national survey data in 2013 showed that obesity increased the risk of developing Diabetes Mellitus almost twice as much, and almost four times the risk of developing comorbidities of Diabetes Mellitus-Hypertension (Kusumawardani et al., 2016). Based on Riskesdas 2018, there was an increase in the trend of central obesity, which was 31.0% compared to 2013 of 26.6%.

Central obesity as a risk factor for prediabetes in some studies can be shown to have a significant relationship, but other studies have not found a significant relationship. Therefore, the author aims to determine the relationship between central obesity and prediabetes in the early detection examination of Non-Communicable Diseases at the Jati Ranggon Health Center in 2023.

Research Methods

This study is a quantitative research using a cross sectional design. The data source in this study uses secondary data from blood sugar screening activities at the Jati Raggon Health Center, in 2023. The target population in the study is all communities in the work area of the Jati Ranggon Health Center in 2023. The source population is the community in the working area of the Jati Ranggon Health Center in 2023 and conducts Non-Communicable Disease examinations, which are 3583 people. Meanwhile, the eligible population is all people in the source population who meet the inclusion criteria. The inclusion criteria for this study are to have data on measurement results such as weight, height waist circumference, fasting blood glucose levels, blood pressure; have data on the results of interviews. While the exclusion criteria in this study are pregnant women, do not have complete data related to the variables to be studied, are diagnosed or have a history of diabetes mellitus by medical personnel, a history of taking diabetes mellitus medication. Based on these criteria, there were 2342 people who could not be included as research respondents so that 1362 eligible research subjects were obtained. The sample selection technique was carried out by means of total sampling where all eligible research subjects were included in the study participants, which was 1241 respondents.

In this study, the independent variables are central obesity, the dependent variable is Prediabetes while the covariate variables are age, gender, smoking, hypertension, general obesity, physical activity. Consume vegetables and fruits. The central obesity variable is known from the results of abdominal circumference measurements using myotape/tape meter. Abdominal circumference is a simple measure and closely correlates with BMI and WHR and is an approximate index of intra-abdominal fat mass and total body fat. The abdominal circumference is measured at the midpoint between the lower border of the ribs and the apex of the iliac. Respondents were said to be centrally obese if the results of abdominal circumference measurements in men were >90 cm and women >80 cm. As for the Prediabetes variable, it was established by measuring blood sugar levels when using capillary blood using a glucometer. Respondents were categorized as prediabetic when the blood sugar level measurement at ≥ was 140 mg/dl. In addition to measuring abdominal circumference and blood sugar levels at any time, blood pressure measurements are also carried out using a digital sphygmomanometer. Respondents were categorized as hypertension if the blood pressure measurement obtained systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg. The measurement of blood sugar levels and blood pressure is carried out by trained health workers. The age variable is only categorized into 2 categories, namely ≥ 45 years old and < from 45 years, this is based on the fact that one of the risk factors for type 2 diabetes that cannot be modified is at the age of ≥ 45 years. In addition to measurements, interviews were also conducted using questionnaires to obtain data on family history of diabetes mellitus, physical activity and smoking habits. For the variable of physical activity, it is categorized as sufficient physical activity if performing body movements that increase energy and energy expenditure with a frequency of 3-5 times a week with a minimum duration of 150 minutes/week.

The stages of data processing that are carried out include data examination (editing) to see the completeness of the data on the screening form, data transformation by providing codes according to research categories (coding), then data cleaning is carried out (cleaning) to check for missing data so that all data obtained is free from errors before analysis. The data analysis technique used univariate and bivariate analysis with the Chi-square test. The size of the association resulting from the bivariate analysis used the Prevalance Ratio (PR) with a confidence level (CI) range of 95%. The collected data is then processed and presented in the form of a table and analyzed descriptively in the form of frequency and percentage distributions.

Results and Discussions

Univariate Analysis

Based on table.1, it is known that the proportion of respondents who have prediabetes status is 18.8% less than non-prediabetic (81.2%). The proportion of respondents who are centrally obese is 39.6%, less than those who are not centrally obese (60.4%). The characteristics of the respondents in this study included most of the patients who were examined for non-communicable diseases who had a lifespan of ≥45 years, which was 50.4%. Based on gender, the proportion of respondents who are female is more at 57.9% compared to the male gender (42.1%). For physical activity, the proportion of those who do physical activity is 70.6%, more than those who do not do physical activity (29.4%). The proportion of employees who are hypertensive is 40.2% compared to those who are not hypertensive (59.8%). Meanwhile, the proportion of those who smoke, more respondents do not smoke (86.6%) compared to those who smoke (13.4%).

Table 1. Frequency distribution based on the characteristics of research respondents

Variable	**N**	**(%)**
Pre Diabetes		
Yes	233	8,8
Not	1009	81,2
Central Obesity		
Yes	491	39,6
Not	750	60,4
Age		
< 45 Years	615	49,6
≥ 45 Years	626	50,4
Gender		
Man	523	42,1
Woman	718	57,9
Smoke		
Yes	166	13,4
Not	1075	86,6
Physical Activity		
Not	365	29,4
Yes	876	70,6
Consumption of Fruits and Vegetables	452	36,4
Not	789	63,6
Yes		
Hypertension		
Yes	499	40,2
Not	742	59,8
General Obesity		

Yes	500	40,3
Not	741	59,7
Variable	**N**	**(%)**

Table 2. showed that out of 30 respondents who were prediabetic, 137 people (27.9%) were centrally obese and 96 people (12.8%) were not centrally obese. The results of the statistical test obtained a value of p <0.001 meaning that there is a significant relationship between prediabetes and central obesity, from the analysis it was also obtained PR = 2.18 (95% CI: 1.68-2.83) which means that respondents who are centrally obese have a 2.18 times greater risk of developing prediabetes compared to respondents who are not centrally obese. This result is not in line with the study of (He et al., 2009) that abdominal circumference does not have a significant relationship with blood sugar levels with a value of p=0.794. However, the results of this study are in accordance with the research of Septyaningrum (2014), in the data analysis obtained the results of p = 0.001 and the relationship coefficient (r) = 0.424, meaning that abdominal circumference has a significant positive relationship with blood sugar levels. Central obesity indicated by abdominal circumference is generally more closely related to type 2 diabetes mellitus or blood sugar levels compared to general obesity (He et al., 2009). Central obesity is an example of dangerous accumulation of body fat caused by lipolysis in this area is very efficient and more resistant to the effects of insulin than adipocytes in other areas (Pusparini, 2007). This is in accordance with Hwa Jung (2016), that visceral fat is more harmful than subcutaneous fat where visceral fat cells release proteins that contribute to inflammation, atherosclerosis, dyslipidemia, and hypertension. As a result, visceral adipose tissue may be more closely associated with type 2 diabetes than other obesity indices. Central obesity can cause type 2 diabetes mellitus caused by insulin resistance which occurs at the same time as increased fat levels in the body (Puspitasari, 2018). According to (Surywan, 2014), an increase in plasma fatty acid concentration can result in insulin resistance. This is due to the competition between fatty acid levels

which increases in circulation and glucose for oxidative metabolism in insulin-responsive cells. Physiologically, an increase in plasma fatty acids within 2-6 hours after lipid insertion into the body can increase insulin secretion, but if an increase in plasma fatty acids occurs over a long period of time (such as in obese patients) it can cause a disruption of the response of β cells to glucose, so that insulin secretion will be impaired (Surywan, 2014).

Table 2. Distribution of the Relationship between Prediabetes and Central Obesity

Variable		**Prediabetes**		**RR Crude**	**95% CI**	***P value***
		Yes	**Not**			
Central Obesity	Yes	137 (27,9%)	354 (72,1%)	2,18	1,68-2,83	<0.001*
	Not	96 (12,8%)	654 (87,2%)			

Table 3. showed that out of 30 respondents who were prediabetic, 145 people (23.2%) were ≥ 45 years old and as many as 88 people (14.3%) were < 40 years old. The results of the statistical test obtained a value of p = <0.001 meaning that there was a significant relationship between prediabetes and the age of the respondent while PR = 1.62 (95% CI: 1.24-2.11) which meant that respondents who were ≥ 45 years old had a

1.62 times greater risk of developing prediabetes compared to respondents at the age of <40 years. This is in line with (Irawan, 2010) research on the Prevalence and Risk Factors of Type 2 Diabetes Mellitus Incidence in Urban Areas of Indonesia (Riskesdas Secondary Data Analysis 2007) that the prevalence of diabetes mellitus is seen to increase with increasing age. Based on the Ministry of Health of the Republic of Indonesia (2016), one of the risk factors for DM that cannot be modified is the age of ≥ 40 years. (Rudi & Kwureh, 2017) argues that with the increase in age, intolerance to glucose also increases. The risk of diabetes increases with age, especially at the age of more than 40 years. This is because at that age there begins to be an increase in glucose intolerance. In addition, the aging process causes a decrease in the ability of pancreatic β cells to produce insulin. In older individuals, there is a decrease in mitochondrial activity in muscle cells by 35%. This is related to an increase in fat levels in the muscles by 30% and triggers insulin resistance (Trisnawati & Setyorogo, 2013).

Based on the relationship with gender, the prevalence of women (21.7%) with prediabetes outcomes was slightly greater than that of men (14.7%). The results of this study are in accordance with (Irawan, 2010) research that the prevalence of type 2 diabetes mellitus is higher in women. In the statistical test, a value of p = 0.005 was obtained, meaning that there was a significant relationship between prediabetes and the gender of the respondents where PR = 1.47 (95% CI: 1.12-1.94) which means that female respondents had a 1.47 times greater risk of developing prediabetes compared to male respondents. This study is not in line with (Komariah & Rahayu, 2020) that there is no relationship between gender and fasting blood sugar levels with a value of p = 0.331. Likewise with the study with (Rahayu et al., 2012), in the results of the statistical test, the value of p = 0.157 (p > 0.05) means that there is no meaningful relationship between sex and the incidence of diabetes mellitus. However, the results of this study are in line with (Rudi & Kwureh, 2017) research, that there is a significant relationship between gender and fasting blood sugar levels with a value of p=0.043. Women suffer more from diabetes mellitus than men compared to men, which is associated with a lack of physical activity in women, especially in housewives. The prevalence of type 2 diabetes mellitus in women is riskier than in men, this is possible from a physical point of view women have a greater chance of an increase in body mass index (Komariah & Rahayu, 2020). In the (Azimi-Nezhad et al., 2008), the prevalence of diabetes mellitus was higher in women than in men, although it was not significant.

Maybe it's because women generally have less activity and spend most of their time at home. According to (Kautzky-Willer et al., 2016), women have an increase in waist circumference that is more prominent with age than men. In elderly subjects in the UK, waist circumference is the best predictor of diabetes mellitus in women, while in men BMI prediction values and waist circumference have comparable values. These results were confirmed by other cohort studies from different countries. In a combined analysis of two prospective population-based cohort studies, women in Germany who had a 1 cm increase in waist circumference had a 31% risk of diabetes incidence per year, compared to a 1 kg increase in body weight 28% likely to develop diabetes. Meanwhile, for men, a 1cm increase in waist circumference ratio has an increased risk of developing diabetes by 29% per year and an increased risk of 34% per year if the man has an increase in weight by 1kg.

The results of the statistical test on the hypertension variable obtained a value of p = <0.001, meaning that there is a significant relationship between hyperglycemia and hypertension. Based on the results of the analysis, PR=1.58 (95% CI: 1.22-2.04) which means that respondents with hypertension have a 1.58 times greater risk of developing prediabetes than respondents who are not hypertensive. In the Midha (2015) study, diastolic blood pressure has a significant relationship with fasting blood cave levels with a value of p<0.001. It was shown that for every 1 mmHg increase in diastolic blood pressure, fasting plasma glucose was estimated to increase by 0.375 mg/dL (β = 0.375) and this association was found to be significant. However, this result is not in line with (Rahayu et al., 2012) where in the results of the statistical test a value of p = 0.784 (p > 0.05) meaning that there is no meaningful relationship between hypertension and the incidence of diabetes mellitus.

Based on the relationship with physical activity, the results of the statistical test obtained a value of p = 0.221 meaning that there was no significant relationship between prediabetes and physical activity where PR = 0.83 (95% CI: 0.62-1.12) which means that respondents who were less physically active had a 0.83 times greater risk of developing prediabetes This is not in line with research (Kriska et al., 2003) that physical activity is related to the occurrence of diabetes mellitus with a P value of <0.05. Physical activity is a major component in the prevention of type 2 diabetes mellitus; even for daily activities such as walking. In a post-hoc analysis of the Finnish Diabetes Prevention Study, walking exercise of at least 2.5 hours a week compared to less than 1 hour was associated with a 63-69% lower risk of developing diabetes. Various consensuses recommend a physically active lifestyle for adults, with a minimum of 30 minutes of accumulated time for 5 or more days a week for moderate-intensity aerobic physical activity or vigorous intensity aerobic physical activity of at least 20 minutes 3 days a week (Balkau, 2008). Exercise *training studies* support the notion that physical activity increases insulin sensitivity independently of any effect of activity on weight loss and fat distribution. This shows that a physically active lifestyle is associated with a low incidence of type 2 diabetes mellitus.

Based on the relationship with smoking habits, the results of the statistical test obtained a value of p = 0.013 meaning that there was a significant relationship between prediabetes and smoking habits where PR = 0.54 (95% CI; 0.33-0.88) which means that respondents who smoke have a 0.54 times greater risk of developing prediabetes compared to non-smoking respondents. In the study of Beziaud (2004), it was shown that there was a significant relationship between smoking and the risk of developing diabetes mellitus, but in women it was less significant. Tobacco consumption leads to an increase in free fatty acids. (Beziaud et al., 2004), speculated that it may be caused by insulin resistance by impaired translocation of GLUT4 by insulin-stimulated in skeletal muscle. According to Taringan (2009) in (Irawan, 2010) smoking is one of the risk factors for the occurrence of type 2 diabetes mellitus. According to the Amarican Diabetes Associations, cigarette smoke can cause oxygen levels in tissues to decrease, increase cholesterol levels and blood pressure and can increase blood sugar levels. Therefore, people who are often exposed to cigarette smoke have a more easy risk of developing dabetes mellitus disease than people who are not exposed to cigarette smoke.

Table 3. Relationship of Covariate Variables to the Incidence of Prediabetes

Variable		**Prediabetes**		**PR**	**95% CI**	***P value***
		Yes	**Not**			
Age	≥45 Years	145 (23,2%)	481 (76,8%)	1,62	1,24-2,11	<0.001*
	<45 years	88 (14,3%)	527 (85,7%)		reff	
Gender	Man	77	446	1,47	1,12-1,94	0,005*

Variable		Prediabetes		PR	95% CI	*P value*
		Yes	Not			
		(14,7%)	(85,3%)			
	Woman	156 (21,7%)	562 (78,3%)		reff	
Smoke	Yes	18 (10,8%)	148 (89,2%)	0,54	0,33-0,88	0,013*
	Not	215 (20,0%)	860 (80,0%)		reff	
Physical Activity	Not	60 (16,4%)	305 (83,6%)	0,83	0,62-1,12	0,221
	Yes	173 (19,7%)	703 (80,3%)		reff	
Consumption of Fruits and Vegetables	Not	91 (20,1%)	361 (79,9%)	1,12	0,86-1,45	0,404
	Yes	142 (18,0%)	647 (82,0%)		reff	
Hypertension	Yes	120 (24,1%)	379 (75,9%)	1,58	1,22-2,04	<0.001*
	Not	113 (15,2%)	629 (84,8%)		reff	
General Obesity	Yes	130 (26,0%)	370 (74,0%)	1,87	1,44-2,42	<0.001*
	Not	103 (13,9%)	638 (86,1%)		reff	

Table 4 shows that the results of the multivariate analysis of the central obesity variable have a 1.87 times higher risk of prediabetes compared to those who are not central obesity, after being controlled with general and statistically significant obesity variables p<0.001 and a CI95% of 1.40 – 2.50.

The Framingham study states that an increase in waist circumference size is associated with high blood sugar levels. Obesity, especially central obesity, is related to *the aging* process. Deposition of fat in the *visceral* area in men occurs during puberty while in women it occurs during menopause. In addition, central obesity is one of the influential factors in triggering insulin resistance. Central fat cells are more resistant to the metabolic effects of insulin and more sensitive to lyotic hormones

With insulin resistance, the body tries to overcome the existing consequences (relative insulin deficiency) by increasing insulin secretion so that there is hyperinsulinemia. As long as the pancreas is still able to meet the body's need for insulin (compensation stage), then the body's metabolism can still be maintained within normal limits. If the pancreas can no longer meet the body's demand for insulin, then the metabolic status will change to hyperglycemia-hyperinsulinemia (impaired glucose tolerance).

Table 4. The Relationship Between Central Obesity and Prediabetes

Variable	PR	p-value	[95% CI]
Central Obesity	1,87	<0.001*	1,40-2,50
General Obesity	1,42	0.017*	1,06-1,89

Conclusion

The results of this cross-sectional study study showed that there was a relationship between central obesity and the incidence of prediabetes (p-value = <0.001). From this study, it can be concluded that central obesity is a risk factor for prediabetes with a prevalence ratio of 1.87. From this study, it was also concluded that central obesity had a 1.87 times risk (95% CI; 1.40-2.50) of prediabetes compared to those who were not central obesity. Based on the results of this study, it can be seen that central obesity is one of the risk factors for prediabetes, so it is necessary to consider early detection of blood sugar checks with central obesity. Lifestyle changes in individuals who have risk factors can prevent prediabetes. To get better results, it is hoped that further research related to prediabetes can complement the weaknesses of the methods and measuring tools in this study. The suggestion for the respondents of this study is to be able to do a healthy lifestyle by doing physical activity for at least 150 minutes a week and maintaining a healthy diet to be able to control risk factors for prediabetes. In addition, it is recommended to conduct periodic physical examinations at the PTM Posbindu or surrounding health facilities.

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