The Relationship between Prediabetes and Body Mass Index of Outpatients at Dr. Dody Sarjoto Hospital at Maros Regency, South Sulawesi, Indonesia

Junedi Sitorus[1], Nurhaedar Jafar[2], Ridwan Amiruddin[3], Sukri Palutturi[4], Veni Hadju[2]

[1]Public Health Doctoral Student, [2]Nutrition Department, Public Health Faculty, [3]Epidemiology Department, Public Health Faculty, Hasanuddin University, Jl. Perintis Kemerdekaan KM.10, Tamalanrea Indah, Kota Makassar, Sulawesi Selatan 9024, Indonesia, [4]Health Administration and Policy Department, Public Health Faculty, Hasanuddin University, Jl. Perintis Kemerdekaan KM.10,

Abstract

Objective: The prevalence of prediabetes is increasing worldwide. According to the International Diabetes Federation in 2016,6.7% of the world's population lived with this condition and estimated to rise to 7.8% in 2040. In general, prediabetes is accompanied by excess body mass index. Therefore, the purpose of this research was to determine the relationship between prediabetes and body mass index of outpatients in the internal medicine polyclinic at Dr. Dody Sarjoto Hospital, Maros Regency, South Sulawesi.

Method: This was an analytical research design with cross sectional approach, involving 143 prediabetes patients. Secondary data were obtained from the record books of the hospital and subjected to Chi Square test.

Result: The highest number of prediabetes cases were within the age range of 40-50 years (58.7%), among female (73.4%), patients with high school education (58.7%), and in 81.1% of patients with family history of DM. Furthermore, the result of the Chi Square test was 0.041, greater than <0.05, indicating a relationship between prediabetes and BMI.

Conclusion: There was a relationship between the cases of prediabetes and BMI of outpatients at dr. Dody Sarjoto Hospital, Maros Regency, South Sulawesi

Keywords: *Prediabetes; Overweight; Obesity; Body Mass Index.*

Introduction

Prediabetes is a health challenge with serious impact and emerging as epidemic in the world, especially in Indonesia. It is a condition characterized with increase in blood glucose known as hyperglycemia, but not high enough to be regarded as diabetes mellitus. The prevalence of prediabetes is increasing every year worldwide, and in 2016, the International Diabetes Federation estimated the adult population with prediabetes to be 6.7%, which was equivalent to 318 million people. It was also estimated that this figure would reach 7.8% in 2040, equivalent to 480 million population of the world.[1] Based on a study, the population of prediabetes in America of people over 20 years old between 1999 and 2010 was 35.5% while the prevalence in UK was 35.5%, 15.5% in China, 14.8% in Spain and 22.4% in Bangladesh.[2] Its prevalence at Indonesia in 2009 was around 10.2% and increased to 36.6% in 2013.[3] According to IDF (2017), Indonesia is the 3rd country with the highest number of prediabetes between the ages of 20 to 79 years. A research showed

Corresponding Author:
Dr. Junedi Sitorus
Public Health Doctoral Student, Hasanuddin University, Jl. Perintis Kemerdekaan KM.10, Tamalanrea Indah, Kota Makassar, Sulawesi Selatan 9024, Indonesia
e-mail: junedi595@gmail.com

that 25% of prediabetes cases within a period of 3-5 years developed into type 2 Diabetes Mellitus (T2DM), about 50% remained as prediabetes, and while 25% reversed to normal blood glucose.[4]

Generally, prediabetes has a great chance of reversing to normal condition, therefore, it could be managed in order to prevent or delay its development into T2DM. One of the best ways of managing it is by avoiding some of the modifiable risk factors such as excess body weight, obesity, lack of physical activity, smoking, alcoholic, hyperlipidemia/dyslipidemia, and high blood pressure. However, the non-modifiable risk factors cannot be avoided by humans and these include age, genetic, and history of diabetes etc.[5] Physiologically, blood glucose are stored in muscle, liver, or fat cells as an energy source, but in insulin resistance condition, glucose are unable to enter these cells, consequently, blood glucose tend to rise but not sufficient to cause diabetes clinically. This condition eventually makes the pancreas unable to secrete insulin as needed, thereby leading to excessive and uncontrolled sugar production in liver, a condition which makes the blood sugar to rise and eventually leads to T2DM.[6]

Diabetes is a metabolic disease characterized by hyperglycemia caused as a result of abnormalities in insulin secretion or action or both.[7]The International Diabetes Federation reported about 382 million DM cases worldwide in 2013 and it was predicted it would rise to 592 million in 2035. Similarly, the World Health Organization (WHO, 2014), reported that 1 million people died as a result of diabetes in year 2000, with a prevalence of around 2%, which then increase to a death of 1.5 million people in 2012 with a prevalence of about 2.7%. Also, 70% of these worldwide deaths due to DM happened in developing countries including Indonesia. According to the results of Basic Health Research (*Riskesdas*) in 2013, the prevalence of diabetes from ages ≥15 years was 6.9% and increased to 10.9% in 2018.[8]

Body mass index (BMI) is an indicator of the level of adiposity in the body, calculated from the body weight (BW) in kilograms divided by height (TB) in meters squared (m^2). It does not directly measure body fat, but shows the body fat measurements such as underweight, normal, overweight and obesity.[9] Underweight increases the risk of infectious diseases while excessive weight i.e, obesity, is an important factor in insulin resistance pathogenesis. BMI is often recommended for evaluating obesity in adults due to the fact it is easier to conduct and inexpensive. BMI level is associated with body fat, which is a risk factor for prediabetes.[10] Obesity is characterized by excessive accumulation of body fat, which increases the risk of hyperglycemia. This condition results in increased secretion of free fatty acids, hormones, and pro-inflammatory substances such as interleukin-6 (IL-6), tumor necrosis factor α (TNFα) which triggers insulin resistance and damage to insulin pancreatic beta cells, which could develop into prediabetes characterized by hyperglycemia.[11] According to a research in South Korea, obesity is 1.5 times at risk of developing into prediabetes.[12] Similarly, the *Riskesdas* data in 2007 showed that obesity significantly increased the possibility of prediabetes by 1.5 times compared with people with normal BMI. The prevalence of obesity according to *Riskesdas* in 2013 was 18.8%, which then increased to 21.8% in 2018.[8] There are various risk factors for obesity, which include genetic, psychological environment, lifestyle, age, sex, economic status, and use of contraception especially the hormonal type. Also, a research showed that obese individuals have 1.63 to 11.58 times greater risk of developing DM compared with non-obese, and the more severe the obesity, the greater the risk of developing DM.[13] Hyperglycemia in overweight and obese people is caused by increase in the free fatty acids which reduce glucose transporter translocation into plasma membrane. This eventually results in insulin resistance in muscle and adipose tissue, initially forming proinsulin with molecules larger than insulin. Usually, proinsulin is stored in the pancreas until it is needed by the body. When secreted into the bloodstream, proinsulin is broken down into 2 parts namely; connecting peptides and active insulin hormones. The main function of the hormones is to reduce glucose levels in the blood. According to Guyton's theory, obesity is a predisposing factor for increased blood sugar. This is because the Langerhans island beta cells are less sensitive to stimulation (insulin resistance) or due to the rising sugar levels and obesity suppresses the number of receptors insulin in cells throughout the body. Therefore, the purpose of this research was to determine the relationship between prediabetes and body mass index (BMI) of outpatients at dr. Dodysarjoto Hospital, Maros Regency, South Sulawesi, Indonesia.

Research Method

This is an analytical descriptive cross sectional study. The research subjects were selected through purposive sampling method, involving all outpatients

treated at Internal Medicine Polyclinic of Dr. Dody Sarjoto Hospital from April 2018 to April 2019. Out of the 2,150 patients sampled during this period, only 143 met both the inclusion and exclusion criteria, hence, were the ones involved in this research. The inclusion criteria include; male and female aged between 18-70 years, fasting blood glucose levels 100-125mg/dl or/and blood glucose levels after 2 hours (post prandial) 140-199mg/dl.

The exclusion criteria are patients with diabetes history and incomplete general data. Secondary data were collected from Dr. Dody Sarjoto Hospital medical record book and the general data were analyzed using SPSS 22 program. The univariate analysis was used to test the normality of the data, as well as the frequency distribution, while bivariate analysis involved the use of Chi-Square Test.

Results

The results of this study are presented in the following table.

Table 1: Characteristics of research respondents.

Characteristics	Frequency	Percentage (%)
Age (Years)		
<28	5	3.5
29 - 39	13	9.1
40 - 50	84	58.7
>51	41	28.7
Gender		
Male	38	26.6
Female	105	73.4
Work		
Yes	62	43.4
No	81	56.6
Education		
D1-D3	21	14.7
S1-S3	28	19.6
Junior High School	10	7.0
Senior High School	84	58.7
DM Family History		
Yes	116	81.1
No	27	18.9
Total	**143**	**100.0**

The highest number of respondents with prediabetes was 84 (58.7%), found between the ages of 40-50 years, while the lowest number of 5 (3.5%) was found at ages <28 years, as shown in Table 1. Also, 81 of the respondents, representing 56.6%, do not work, while the highest number of prediabetes had senior high school as the highest level of education, 84 (58.7%). In addition, there were more respondents, 116 (81.1%), with family history of DM.

Table 2 The data of body mass index.

Body Mass Index	f	%
Normal	6	4.2
Overweight	128	89.5
Obese	9	6.3
Total	143	100.0

Based on Table 2, there were only 6 respondents (4.2%) with normal BMI, majority, 128 people (89.5%) were overweight while 9 people (6.3%), were found to be obese.

Table 3 Chi-Square test.

	Value	Df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	9.800a	4	.044	.041
Likelihood Ratio	13.460	4	.009	.014
Fisher's Exact Test	9.962			.019
N of Valid Cases	143			

Based on Table 3, the Chi-Square results was 0.041, since this figure <0.05, it means that there is a relationship between prediabetes and body mass index.

Discussion

Prediabetes is a condition characterized by elevated blood sugar above the normal but not sufficient to be recognized as diabetes mellitus. The age range with the highest number of prediabetes was 40-50 years, with 84 (58.7%) people. The high prevalence of prediabetes in this age range was due to the aging process taking place at that point. The production of enzymes associated with insulin is disrupted at this point. Also, there are changes in cell permeability, as well as the response of cell nucleus to insulin, a condition which allows an increase in the blood glucose. There were more cases of prediabetes among women because they generally have less muscle mass, consequently, it is easy to experience insulin resistance within the muscles in moderate to severe levels. Additionally, there were prediabetes cases among patients with no permanent job due to the fact that

they do not perform routine physical activity. Majority of these people just sit at home and watch television, a behavior which increases the risk for prediabetes. The highest number of cases was found among in the high school graduates.

This is possibly due to the fact the largest range of graduated in Indonesia are from the public high schools, hence, more respondents were at this education level. People with family history of DM have a higher risk of coming up with prediabetes. The results of this study support this fact with Table 1 showing 116 (81.1%) prediabetes cases with family history of DM. This is in line with the the results of a multicenter research conducted by Wagner in Germany which showed that family history of DM was significantly associated with the emergence of prediabetes (OR = 1.4 with 95% CI = 1.27: 1.54 p <0.001). It further stated that family history of DM increased the risk of prediabetes by around 40%.[14] In general, there are more obese people with prediabetes compared with individuals with normal body weight. In addition, BMIs above the normal limits have a higher tendencies of coming up with various kinds of complications such as prediabetes, diabetes, hypertension, etc. According to a study, BMI mechanism plays a major role in insulin resistance, as BMI above normal causes peripheral resistance to glucose uptake, thereby decreasing the sensitivity of pancreatic beta cells.[15] Moreover, a research showed that 80% of obese or overweight people experience hyperglycemia[16], while another research conducted in Iraq showed that BMI <25 kg/m^2 had 2.7 times risk of causing hyperglycemia.[17]

Insulin resistance in prediabetes happens in the muscle, liver, and fat tissues. Additionally, the result obtained from the Chi-Square test was 0.041, meaning that there was a relationship between prediabetes and the BMI, as there were more cases among obese patients compared with people with normal body weight. This could be due to the accumulation of excess visceral fat in prediabetes patients which causes insulin resistance in the liver and muscles, and consequently glucose uptake leading to hyperglycemia. The adipose tissue is recognized as an endocrine organ producing several peptides which are both proinflammatory and anti-inflammatory. This inflammatory process causes dysfunction in pancreas causing insulin resistance, and if this condition continues, it leads to increase in glucose levels and impaired lipid metabolism.[1] Under normal conditions of sufficient and sensitive insulin levels, the insulin works on its receptors found on the cell surface, enters the cells and eventually allows glucose to enter the cells, which are used as energy or as energy reserve, with normal blood glucose level the end result.[17] This is not the situation in obese people, as increase in lipopolysaccharides (LPS) mRNA induces TNF-α factors and protein levels, a process leading to inflammatory processes in leptin-1 and PAI-1 obese patients. In general, an increase in TNF-α in fat tissue of obese patients is an indication of insulin resistance.

Furthermore, obesity is a dominant cause of insulin resistance associated with decrease in the number of receptors and the failure of post-receptor to activate the tyrosine kinase, which is a subunit B in the insulin receptor. Activating this complex activates beta-phosphorylase and insulin-mediated action which control blood sugar levels. Consequently, hyperinsulinemia arises due to the failure in the delivery of signals to regulate blood sugar levels. Generally, the risk factors of diabetes include hereditary factors, physical activity, dietary intake, metabolism and hormonal metabolism. Increased glucose and fat usually result in increased transport of fatty acids into adipose and lipogenesis, which is under the influence of insulin. Also, partial oxidation of fatty acids produces ketones which are alternative fuel source for the brain and various organs. Moreover, fat tissues are known not only as storage points for energy reserves but as dynamic network with various functions. This condition of excess fat tissue common in the modern society is also associated with insulin resistance.[18]

Conclusion

Based on the *Chi square* result, 0.041 (<0.05), there is relationship between prediabetes and BMI of outpatient at Dr. Dody Sarjoto Hospital, Maros Regency, South Sulawesi, Indonesia.

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