

Path Analysis of the Effect of Waist-Pelvic Circumference, Body Mass Index, and Abdominal Circumference on the Occurrence of Prediabetes

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ABSTRACT

Background: Diabetes mellitus is an important health problem in the world. Pre-diabetes is a state of blood sugar levels above normal but below the criteria for diabetes. American Diabetes Association (ADA) uses criteria for hemoglobin A1C (HbA1C) levels of 5.7% to 6.4% to define pre-diabetes. The prevalence of pre-diabetes was the highest in overweight individuals. In many studies, body fat levels were assessed by indicators of waist-pelvic circumference, abdominal circumference, and BMI. Among the three, it is still a debate which is more influential on the condition of pre-diabetes. The purpose of this study was to determine the effects of waist-pelvic circumference, BMI, and abdominal circumference in pre-diabetes.

Subjects and Method: A cross sectional study was conducted at Prodia Clinic, Surakarta, Central Java, from January to March 2019. A sample of 200 study subjects was selected by fixed disease sampling. The dependent variable was pre-diabetes. The independent variables were waist-pelvic circumference, BMI, and abdominal circumference. The data on HbA1C were measured by NGSP standardized ion exchange HPLC method. The data were analyzed by path analysis.

Results: Abdominal circumference >90 cm in men and >80 cm in women ($b = 0.87$; 95% CI = 0.23 to 1.51; $p = 0.008$) and age ≥ 45 years old ($b = 1.70$; 95% CI = 0.93 to 2.46; $p < 0.001$) were directly increased pre-diabetes. Pre-diabetes was indirectly affected by waist-pelvic circumference, gender, and obesity.

Conclusions: Abdominal circumference >90 cm in men and >80 cm in women and age ≥ 45 years old are directly increased pre-diabetes. Pre-diabetes is indirectly affected by waist-pelvic circumference, gender, and obesity.

Keywords: prediabetes, abdominal circumference, waist-pelvic circumference, body mass index

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BACKGROUND

Diabetes mellitus was an important health problem in the world. The prevalence of pre-diabetes was increasing throughout the world so it is estimated that by 2030 more than 470 million people will become pre-diabetes (Tabák et al., 2012). In Indonesia, the prevalence of pre-diabetes reached 10% (Soewondo and Pramono, 2011).

A person with a prediabetes can become DM within 10 years if they do not

change their lifestyles. Interventions with losing weight, regulating diet and increasing physical activity can reduce risk by 58% (Compánán-Ortiz et al., 2018)

The American Diabetes Association (2019) uses the criteria of fasting blood sugar 100 to 125 mg/dl and post prandial 2 hour blood sugar 140 to 200 mg/dl, or hemoglobin A1c (HbA1C) levels 5.7% to 6.4% for define pre-diabetes. HbA1C can be used to predict pre-diabetes with the same

predictive value as GDP and GD2PP (Vijayakumar et al., 2017). Studies on pre-diabetes in Indonesia using HbA1C are still limited.

Along with the increase of body mass index becoming abnormal, abdominal circumference and the ratio of hip waist circumference to the risk of type 2 DM increase, and when abdominal circumference and the ratio of waist to hip return to normal DM risk also decreases (Yang et al., 2016). The prevalence of pre-diabetes is highest in overweight individuals, and increases in all BMI groups included in the normal BMI area. In many studies, body fat levels were assessed by indicators of waist hip ratio, abdominal circumference and the most common use of BMI (Czernichow et al., 2011). Based on this background, the purpose of this study was to determine the effect of waist-pelvic circumference, BMI and abdominal circumference in pre-diabetes.

SUBJECTS AND METHOD

1. Study Design

This was an analytic observational study with a cross sectional study approach. It was conducted at the Prodia Clinic in Surakarta, Central Java, Indonesia for three months from January to March 2019.

2. Population and Samples

The population in this study was patients who underwent HbA1C without a history of DM. A sample of 200 study subjects was selected by fixed disease sampling.

3. Study Variables

The dependent variable in this study was HbA1C levels. The independent variables of this study were body mass index, abdominal circumference, hip waist circumference, age, and gender.

4. Operational Definition

Pre-diabetes. Prediabetes was defined as a level of HbA1C 5.7 to 6.4%.

Age. Age was defined as the age of study subjects when measurements are based on date of birth.

Gender. Gender was defined based on the characteristics of men and women.

Body Mass Index. The body mass index was defined as the value obtained from the calculation between body weight (kg) divided by the square of the height (m²).

Abdominal circumference. The abdominal circumference was defined as the size of the body circumference in the middle between the rib cage which can be felt by the upper part of the iliac crest.

Waist-pelvic circumference. Waist-pelvic circumference was defined as a comparison of waist circumference and hip circumference.

5. Study Instruments

The data were obtained using direct measurements with scales, microtoise, measurement tape, and questionnaire. Measurement of HbA1C levels were obtained using the NGSP standardized ion exchange HPLC method.

6. Data Analysis

Univariate analysis was used to show frequency distribution and percentage characteristics of research subjects. Bivariate analysis was done using chi square test. Multivariate analysis was performed using path analysis. Five steps of path analysis have been carried out, namely: model specifications, model identification, model suitability, parameter estimation, model specification.

7. Research Ethics

The research ethics included inform consent, anonymity, confidentiality, and research ethics. This study received ethical ethics from the Research Ethics Committee Faculty of Medicine, Universitas Sebelas Maret, Surakarta, with number 161/UN27.06/KEPK/201.

RESULTS

1. Samples Characteristics

The sample characteristics are illustrated in Table 1.

Table 1. Samples Characteristics

	Characteristics	n	%
Gender	Female	114	57
	Male	86	43
Age	≥45	124	62
	<45	76	38
BMI	High (≥25)	98	49
	Normal (<25)	102	51
Abdominal circumference	High (men >90, women >80)	84	42
	Normal (men ≤90, women ≤80)	116	58
Circular ratio waist-hip	High (men ≥0.9; women ≥0.85)	90	45
	Normal (men <0.9; women <0.85)	110	55

2. Bivariate Analysis

Bivariate analysis in table 2 shows the effect of age, gender, abdominal circumference, BMI, and waist-pelvic waist circumference on prediabetes. Age ≥45 years (OR = 5.43, p <0.001), abdominal circumference (OR = 2.36, p= 0.005), BMI (OR= 1.16, p= 0.617), waist-pelvic circumference (OR = 1.87, p = 0.043) increased pre-diabetes. Female gender reduced the prevalence of pre-diabetes (OR= 0.79, p = 0.426).

Table 2. Bivariate analysis

Independent variable		HbA1C				Total		OR	p
		<5.7%		≥5.7-6.4%		n	%		
		n	%	n	%				
Gender	Female	79	69.3	35	30.7	114	100	0.79	0.426
	Male	55	64	31	36	86			
Age	≥45	68	54.8	56	45.2	124	100	5.43	<0.001
	<45	66	86.8	10	13.2	76			
BMI	Overweight	64	65.3	34	34.7	98	100	1.16	0.617
	Normal	70	68.6	32	31.4	102			
Abdominal circumference	High	47	56	37	44	84	100	2.36	0.005
	normal	87	75	29	25	116			
Waist-pelvic circumference	High	67	60.9	43	39.1	90	100	1.87	0.043
	Normal	67	74.4	23	25.6	110			

3. Path Analysis

Path analysis run on Stata 13 program. Table 3 described the results of pathway analysis in which abdominal circumference > 90 cm in men and > 80 cm in women had a direct positive effect on the risk of pre-diabetes.

The higher the abdominal circumference, the higher the risk of pre-diabetes, and it was statistically significant (b = 0.87; CI_{95%} = 0.23 to 1.51; p = 0.008).

Age ≥45 years had a direct positive effect on the risk of pre-diabetes. The older they get, the higher the risk of pre-diabetes, and it was statistically significant (b = 1.70; 95% CI = 0.93 to 2.46; p <0.001). Waist-hip circumference ratio ≥0.9 in men and ≥0.85 in women, female gender and BMI ≥25 kg/m² had an indirect positive relationship with pre-diabetes through abdominal circumference, which was statistically significant.

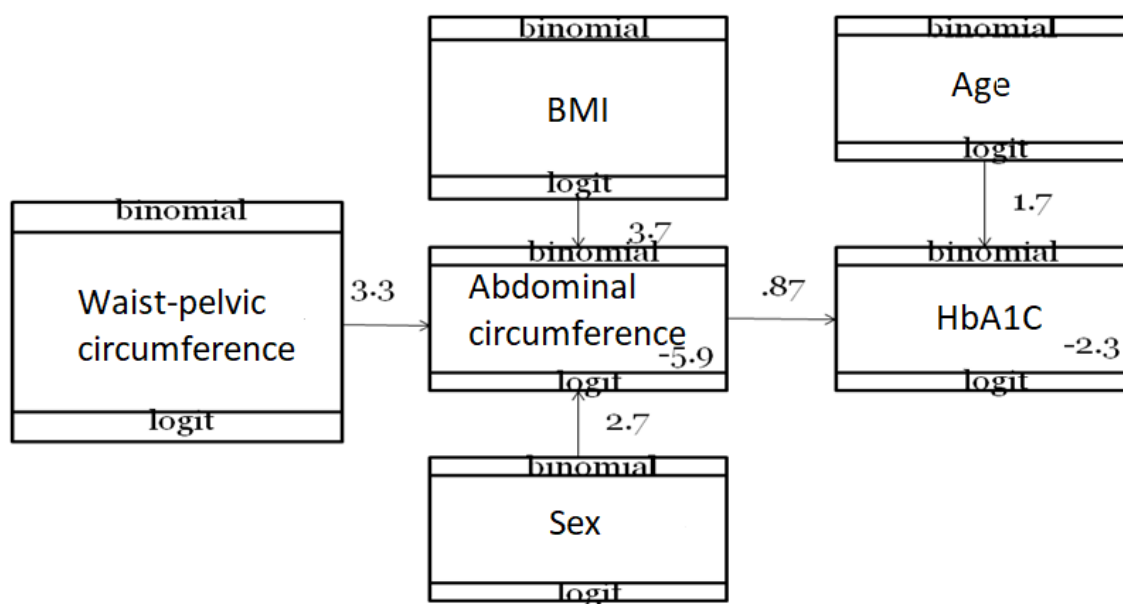


Figure 1. Path analysis model specifications

Table 3. The results of path analysis

Dependent variable	Independent variable	b	95% CI		p
			Lower limit	Upper limit	
Direct effect					
Prediabetes (HbA1C 5.7-6.4%)	← Abdominal circumference (male >90 cm, female > 80cm)	0.87	0.23	1.51	0.008
	← Age (≥45 years old)	1.70	0.93	2.46	<0.001
Indirect effect					
Abdominal circumference (male >90 cm, female > 80cm)	← Waist-pelvic circumference (male <0.9, female <0.85)				
	← BMI (≥25 kg/m ²)				
	← Female sex				
N observation= 200					
Log likelihood=-178.8					
AIC = 371.6					
BIC= 394.7					

DISCUSSION

1. The Effect of abdominal circumference on prediabetes

Abdominal obesity in men and women has the strongest relationship with prediabetes (Díaz-Redondo et al., 2015). This was in accordance with the study of Luo et al. (2013) and Chen et al. (2015) study that showed changes in abdominal circumference were better at predicting the risk of type 2 DM. An increase in abdominal circumference reflected accumulation of adi-

pose fat tissue which caused insulin resistance (Kashiwagi et al., 2017).

2. The effect of age on prediabetes

Fat percentage increases with age (Compánán-Ortiz et al., 2018). Pancreatic function, tissue sensitivity to insulin and insulin receptor activity decreases and muscle tissue decreases, consequently blood glucose increases so that HbA1C levels also increase (Pani et al., 2008). Secondary effects of body fat and physical fitness also occur with age (Yanai et al., 2018).

3. The effect of waist-pelvic circumference, BMI, and gender on pre-diabetes through abdominal circumference

In accordance with Abtahi et al. (2010) study which showed that a person with BMI, abdominal circumference and hip waist circumference ratio increased, the risk of pre-diabetes also increased. The hip waist circumference ratio was strongly associated with the risk of type 2 DM (Mansour and Al-Jazairi., 2007). The hip waist circumference ratio describes body fat distribution, but the abdominal circumference had a stronger relationship with metabolic and cardiovascular risk factors in accordance with a study conducted by Wahyuni and Murbawani (2016).

A study conducted in India also shows that BMI can be used to detect prediabetes early (Pandey et al., 2017). BMI is associated with body fat percentage, while abdominal circumference is associated with visceral fat (Wang et al., 2013). BMI is influenced by age, sex and ethnicity (Beydoun and Wang., 2009) and cannot distinguish visceral fat from body fat (Wang et al., 2018).

This study was consistent with a study in Mexico where women showed higher body fat percentage than men (Compeán-Ortiz et al., 2018). Women exercise less and manage stress worse than men (Wang D, 2013). Women with higher estrogen associated with high BMI (Åkesson et al., 2015) so that it is significantly the cause of higher HbA1C levels (Yuan et al., 2014).

The strength of this study is to use HbA1C levels for determining the criteria for prediabetes. The limitation in this study was not to distinguish prediabetes samples at high risk of DM (HbA1C 5.7 to 5.9%) and the risk of low DM (HbA1C 6 to 6.4%). Further studies need to narrow the characteristics of the research sample so that the results of the

study are better. The results of this study concluded that the higher the abdominal circumference (male > 90 cm and women > 80 cm) and age \geq 45 years increased the risk of prediabetes.

AUTHOR CONTRIBUTION

Cindy Lestyani Loekito collected the data and wrote the manuscript. Bhisma Murti did path analysis and interpreted data analysis. Eti Poncorini Pamungkasari suggested the materials to discuss in the manuscript.

CONFLICT OF INTEREST

We declared that there was no conflict of interest.

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