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Association Between Body Roundness Index (BRI) and Waist-To-Height Ratio (WHTR) to Blood Glucose Levels Among Office Workers in Jakarta

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ABSTRACT

Despite the absence of a statistically significant association between Body Roundness Index (BRI) and Waist-to-Height Ratio (WHtR) with blood glucose levels, this study underscores the practical value of both anthropometric indices as early screening tools for diabetes risk among office workers. The high proportion of participants classified as at risk—64.6% by BRI and 80% by WHtR—indicates a notable prevalence of central obesity, which is a well-established precursor to insulin resistance and hyperglycemia. In workplace health promotion programs, particularly within sedentary environments such as offices, simple, low-cost, and non-invasive tools like BRI and WHtR can facilitate routine screening for metabolic risks. These tools allow health practitioners and occupational health units to identify individuals with increased cardiometabolic risk and recommend timely lifestyle interventions, such as structured physical activity, dietary modifications, and regular glucose monitoring. Moreover, WHtR, which showed a higher sensitivity in this population, may serve as a more practical parameter for large-scale screenings. Given their ease of use and predictive potential, incorporating BRI and WHtR into employee health assessments may significantly enhance early detection and prevention efforts for diabetes mellitus. Future studies could explore their longitudinal predictive accuracy and integration into digital health platforms for continuous monitoring in workplace settings.

Keywords: Body Roundness Index; Blood Glucose Levels; Office Workers; Waist-to-Height Ratio

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Introduction

In Indonesia, 28 percent of the population has central obesity, and 40.9 percent of them have prediabetes. Prediabetes increases a person's risk of developing diabetes in the future (Harbuwono et al., 2018; Zhao et al., 2018). Basic Health Research (Riskedas) in 2013 noted that the number of individuals with diabetes in Indonesia doubled to 12 million people. In Jakarta itself, there are 190 thousand residents who were diagnosed with diabetes mellitus (Badan Penelitian dan Pengembangan Kesehatan, 2013). There is a close association between central obesity and diabetes. Central obesity is an accumulation of fat in the abdominal region and is considered a significant risk factor for the formation of cardiovascular diseases, such as diabetes mellitus type 2. High visceral fat causes insulin resistance, which is the cause of type

2 diabetes (Makki et al., 2013; Papaetis et al., 2015; S. K. Trisnawati & Setyorogo, 2013). Many researches has been done on anthropometric measurements that can determine central obesity.

Waist to Height Ratio (WHtR) and Body Roundness Index (BRI) are new measurement indices that have gained attention as a good index in predicting risk factors for cardiovascular disease, such as hyperglycaemia, dyslipidaemia, and hypertension (Ashwell M, 2016; Djap HS Sutrisna B, 2018; E-G, 2016; Nakamura K Nanri H, 2011; Tian S Zhang X, 2016). Both measurements are considered better in determining the percentage and distribution of body fat, so they can be used as a predictor in determining the risk of developing diabetes (Ashwell M, 2016; Chang et al., 2018; Chang Y Guo X, 2015; Djap HS Sutrisna B, 2018; E-G, 2016; Liu et al., 2018; Nguyen et al., 2023; Tian S Zhang X, 2016). WHtR is considered to have advantages because it does not depend on age, gender, and race. Then, BRI is a measurement index developed by Thomas et al. connecting the waist circumference with height so that an oval shape is formed (Thomas & Ely, 1996).

WHtR and BRI are considered better than previous measurements because they consider waist circumference and height, so there is no overestimating or underestimating in individuals of different heights (Ashwell M, 2016; E-G, 2016; Son YJ Kim J, 2016). Previous anthropometric measurements, such as Body Mass Index (BMI), cannot determine the percentage of visceral fat and differentiate muscle mass from fat, so that individuals with high muscle mass are often incorrectly categorized as obese (Buss, 2020). Several factors may cause diabetes mellitus, both internal and external. Work factors such as working hours, work environment, and stress can cause lifestyle changes (N, 2001; Nagaya T Yoshida H, 2006; Vazquez LA Calvo-Bonacho E, 2019). The International Diabetes Federation (IDF) 2017 predicts that the prevalence of diabetes will increase in urban areas, due to lifestyle changes such as lack of physical activity and poor eating habits associated with work (Aaboud et al., 2017). In Indonesia alone, the prevalence of diabetes in urban areas is twice as large than in rural areas (Badan Penelitian dan Pengembangan Kesehatan, 2013).

Several previous studies have shown that anthropometric indices such as the Waist-to-Height Ratio (WHtR) and the Body Roundness Index (BRI) have better predictive ability than conventional indices such as the Body Mass Index (BMI). For example, studies by Ashwell et al. (2016) and Maessen et al. (2014) confirmed that WHtR is more sensitive in detecting metabolic risks, including hyperglycemia, than BMI because it considers abdominal fat distribution. Meanwhile, Thomas et al. (2013) developed BRI as a body shape indicator that is closely correlated with body fat percentage and metabolic disease risk. Research by Chang et al. (2015) also proved that BRI can predict type 2 diabetes mellitus more accurately than BMI in Asian populations. However, most of these studies were conducted in the general population or outpatients, not in groups of office workers who are at risk of sedentary lifestyles. Therefore, this study offers novelty by focusing on the use of WHtR and BRI as diabetes risk screening tools in office workers in an urban environment, such as Jakarta, who tend to have typical patterns of work activity and stress (Vazquez LA Calvo-Bonacho E, 2019).

This study aimed to determine whether there is an association between BRI and WHtR and blood glucose levels among office workers in Jakarta and whether BRI and WHtR can be used to determine the increased risk of diabetes among office workers in Jakarta.

Method

This research employed a cross-sectional study design. Sampling was conducted using a simple random sampling technique among employees of the Atma Jaya Catholic University of Indonesia, encompassing the Semanggi and Pluit Campuses. A total of 65 respondents participated in the study, proportionally divided based on the number of workers at each campus location. Data collection involved anthropometric measurements, including waist circumference, height, and capillary blood glucose levels, all performed with the assistance of

trained medical personnel. Additionally, respondents completed a validated dietary habits and physical activity questionnaire using the International Physical Activity Questionnaire (IPAQ). Data analysis was carried out using the Mann-Whitney U test to assess differences in blood glucose levels based on BRI and WHtR risk classifications. This non-parametric test was selected due to the non-normal distribution of blood glucose data, ensuring the robustness of statistical inference in detecting associations between anthropometric indices and glycemic outcomes.

Results and Discussion

Table 1 shows an overview of the characteristics of respondents from Atma Jaya Catholic University of Indonesia Semanggi and Pluit Campus. Based on demographic data, it is known that most of the respondents in this study were in the age group of 31 to 50 years (61.5%), with a high level of education (graduated from college). Based on habits, it can be seen that there are 13 workers (20%) who smoke and 8 people who consume alcohol (12.3%). Based on cardiometabolic risk factors, there are 10 workers with high blood pressure (15.4%) and 16 people with high cholesterol (24.6%). Nearly a third of respondents have a family history of diabetes. The majority of workers have low and moderate physical activity; there are 25 workers with a low physical activity level (38.5%) and 27 people with a moderate physical activity level (41.5%). There are 42 respondents who are in the BRI risk category (64.6%), while in the WHtR risk category, there are 52 respondents (80%).

Table 1. Respondents Characteristics

Respondent Characteristics	n	(%)	Min	Max	Mean
Height			146	180	161,5
Waist Circumference			60	140	92,16
BRI			1.24	11.79	4.96
WHtR			0.37	2.31	0.62
Blood Glucose Levels			77	218	116.23
• Normal	57	87.7			
• Prediabetes	2	3.1			
• Diabetes	6	9.2			
Age			22	69	42
• 20-30	8	12.3			
• 31-50	40	61.5			
• >50	17	26.1			
Gender					
• Male	32	49.2			
• Female	32	50.8			
Education					
• Junior/Senior High School	12	18.5			
• College	53	81.5			
Habits					
• Smoking	13	20			
• Alcohol	8	12.3			

Respondent Characteristics	n	(%)	Min	Max	Mean
Cardiometabolic Risk Factors					
• High Blood Pressure	10	15.4			
• High Cholesterol	16	24.6			
Antidiabetic Medication	4	6.1			
Family History of Diabetes	20	30.7			
Physical Activity					
• Light	25	38.5			
• Moderate	27	41.5			
• Vigorous	13	20			
BRI					
• At risk	42	64.6			
• No risk	23	35.4			
WHtR					
• At risk	52	80			
• No risk	13	20			

Based on Table 2, it can be seen that in the risk group according to BRI, there are 35 respondents with normal blood glucose levels (53.85%), 2 with prediabetes (3.1%), and 5 with diabetes (7.7%). Whereas in the BRI no risk category, there were 22 normal blood glucose level respondents (33.85%), no prediabetes respondents, and 1 respondent with diabetes (1.5%). Later, using a bivariate analysis, a non-parametric test, 2 independent samples, Mann-Whitney U, we obtained a p-value of 0.159 (p-value> 0.05). Based on the p-value, it was concluded that there was no significant association between the Body Roundness Index (BRI) and blood glucose levels.

Table 2. Association between BRI and Blood Glucose Level

		Blood Glucose Levels						Total		*p* value
		Normal		Prediabetes		Diabetes		n	%	
		n	%	n	%	n	%			
Body Roundness Index	At risk	35	53.85	2	3.1	5	7.7	44	67.7	0.159
	No risk	22	33.85	0	0	1	1.5	23	35.4	
Total		57	87.7	2	3.1	6	9.2	65	100	

Based on Table 3, it can be seen that in the risk group according to WHtR, there were 44 non-DM respondents (67.7%), 2 prediabetes (3.1%), and 6 people with diabetes (9.2%). In the no-risk category, 13 respondents had normal blood glucose levels (20%), and no respondents had prediabetes or diabetes. Later, using the same test, we obtained a p-value of 0.135 (p-value> 0.05). Based on the *p-value*, it can be concluded that there is no significant association between Waist to Height Ratio (WHtR) and blood glucose levels.

Table 3. Association between WHtR and Blood Glucose Level

	Blood Glucose Levels						Total		*p* value
	Normal		Prediabetes		Diabetes		n	%	
	n	%	n	%	N	%			

Waist to Height Ratio	At Risk	44	67.7	2	3.1	6	9.2	52	80	0.135
	No Risk	13	20	0	0	0	0	13	20	
Total		57	87.7	2	3.1	6	9.2	65	100	

The age of the workers in this study is suitable for the Major Labour Laws of Indonesia, the minimum age of work is 18 years (Statistik, 2018). According to the 2018 Sakernas Survey, the majority of workers in Indonesia are over 25 years old (Statistik, 2018). The average age of workers in this study is also consistent with research conducted on workers in Japan, which is around 42 years (Nagaya T Yoshida H, 2006). The number of workers with diabetes mellitus in this study is 6 people (9.2%), which is greater compared with the prevalence of diabetes in Jakarta according to Riskesdas 2013 data, which is 2.5% (Badan Penelitian dan Pengembangan Kesehatan, 2013). It is also known that all workers who have diabetes mellitus in this study are over 40 years old. This is supported by research conducted on Japanese workers, which says that there is an increased risk of diabetes in workers aged over 40 years (Nagaya T Yoshida H, 2006). This statement is also supported by research conducted in West Jakarta and Surabaya, where an increase in diabetes prevalence occurs with age, especially at the age of more than 40 years (S. K. Trisnawati & Setyorogo, 2013)

In this study, it was found that out of 6 workers with diabetes mellitus, 5 of whom had graduated from college (PT), this was supported by Riskesdas (2013) data that there is an increased prevalence of diabetes with a higher education level. There were 20 workers who had a family history of diabetes, such as their biological relatives, such as father, mother, grandmother, and grandfather. Among those 20 people, 3 of them have diabetes and 1 of them has prediabetes. This is also by the Indonesian Ministry of Health and Trisnawati. This suggested that there is an increased risk of DM if there is a history of DM in the family (S. K. Trisnawati & Setyorogo, 2013). Risk factors of cardiometabolic diseases, such as high blood pressure and high cholesterol, are associated with the incidence of diabetes mellitus (N, 2001). High cholesterol levels increase free fatty acids, which can damage beta cells of the liver, which ultimately causes insulin resistance in type 2 (Soewondo P, 2011). Individuals with high blood pressure have a greater risk of developing diabetes, due to the thickening of arteries, which causes narrowing of blood vessels, so the process of transporting glucose from the blood becomes disrupted (Trisnawati SK, 2013). In this study, there were 14 workers with high cholesterol, 2 of them had diabetes, and 1 person was classified as prediabetic. Also, there are 10 workers who have high blood pressure, and 3 of them have diabetes.

Based on habits, there are 13 workers who have a smoking habit, and there are 8 workers who regularly consume alcohol. According to the research of Nakanishi et al., Poor lifestyles such as alcohol consumption, smoking, decreased physical activity, and poor diet are influenced by the work environment (N, 2001). Smoking is one of the risk factors for type 2 DM Nicotine can stimulate the adrenal glands and increase blood glucose levels (Trisnawati SK, 2013). Work can affect one's lifestyle due to stress and busyness at work. Workers spend their daily lives sitting in the office and have a sedentary lifestyle (Nagaya T Yoshida H, 2006). Based on the distributed IPAQ questionnaire, the average hours of sitting per day for workers in this study were 5.4 hours, with the longest being 12 hours. Then, the majority of the levels of physical activity among workers in this study are light and moderate. Out of 65 respondents, 25 people (38.5%) had light physical activity and 27 people (41.5%) had moderate physical activity.

According to research by Nurayati et al. conducted in Surabaya, light physical activity is one of the risk factors for diabetes type 2 (RI, 2008). Based on Table 1, it is known that almost half of the workers in the study often ate oily foods, and also some of the workers frequently consumed fast food. Consuming fatty foods and a lack of physical activity can cause obesity, which is a risk factor for diabetes (N, 2001; Nagaya T Yoshida H, 2006; RI, 2008; A. E. Trisnawati et al., 2018).

Based on the results data in Table 2, it was found that there was a tendency for BRI to have a significant association with blood glucose levels. It can be seen that workers with diabetes are classified in the risk category according to BRI. However, based on the results of the statistical tests that were performed, the p-value of 0.159 was obtained, which is greater than 0.05. So, based on the statistical test, it can be concluded that a significant association was not found between BRI and blood glucose levels in this study. This is supported by the study conducted in China. It states that BRI anthropometric measurements are no better than previous measurements such as waist circumference, Body Mass Index (BMI), and Waist to Height Ratio (WHtR) (Chang Y Guo X, 2015). However, other studies were conducted in China among the adult and elderly population. It is said that BRI can be used as an alternative index in predicting prediabetes and diabetes, with the highest predictive capacity compared to ABSI and BMI, and can also provide accurate predictions of body fat percentage (Zhao Q Zhang K, 2018). Then, based on Chinese health survey data research, it is also said that BRI is better at determining risk cardiometabolic diseases such as diabetes, hypertension, and dyslipidaemia compared to BMI, waist circumference, and WHtR (Tian S Zhang X, 2016). According to research conducted in Turkey, it is said that BRI can be used as an alternative index in predicting cardiometabolic risk and this study is also not by research conducted in Beijing among the adult population, which says BRI can be used as an alternative index in predicting diabetes after WHtR (Liu PJ Ma F, 2017; of Two New Anthropometric Indices (A Body Shape Index & in Obese Individuals, 2018). It was also found that there was a tendency for WHtR to have a significant association with blood glucose levels. It can be seen that all respondents with diabetes were classified in risk categories according to WHtR. It is also known that WHtR is more sensitive because it classifies more individuals into risk categories, this is by the study of Ashwell et al. (2016) However, based on the results of statistical tests that have been carried out, p values of 0.135 are obtained, the p value is greater than 0.05. So, based on statistical tests, it can be concluded in this study that there is no significant association between WHtR and blood glucose levels. This is supported by Bener et al. (Bener A Yousafzai MT, 2013) research, which states that waist circumference measurement is still better than WHtR in men and women.

But this is not supported by other studies, as in a study conducted in Asian countries among adult populations, suggesting that WHtR anthropometric measurements are better than previous anthropometric measurements, such as waist circumference and BMI, in predicting the risk of metabolic disease (E-G, 2016). Then there is also a study in China stating that WHtR is a better predictor for diabetes than BMI, especially in men (Zhao Q Zhang K, 2018). In a study conducted in South Korea, a significant association was found between the development of diabetes and WHtR, so that WHtR is a better diabetes risk predictor than BMI (Son YJ Kim J, 2016). Research in Beijing also said that WHtR can be used as a better predictor of cardiometabolic disease risk than BRI and ABSI (Liu PJ Ma F, 2017)Research in Indonesia,

based on 2013 Riskesdas data, states that WHtR can be used as a predictor of prediabetes and diabetes in the Indonesian population.

Conclusion

This study found that a large proportion of office workers in Jakarta were classified as at risk for diabetes according to Body Roundness Index (BRI) and Waist-to-Height Ratio (WHtR), with 64.6% and 80% of participants falling into the risk category, respectively. However, the bivariate analysis did not show a statistically significant association between BRI ($p = 0.159$) or WHtR ($p = 0.135$) and blood glucose levels. Despite the lack of significance, the high proportion of individuals categorized as at risk suggests that BRI and WHtR may still serve as valuable tools for initial risk screening. Given their simplicity, non-invasiveness, and cost-effectiveness, these indices can be integrated into routine occupational health assessments and public health screenings to flag individuals who may benefit from further metabolic evaluations.

Future research should focus on improving the predictive accuracy of BRI and WHtR by integrating them with other clinical markers, such as HbA1c, insulin resistance indicators, or lipid profiles. Longitudinal studies are also recommended to assess whether baseline BRI and WHtR can predict future development of diabetes mellitus, particularly in populations with sedentary work environments. Additionally, combining anthropometric indices with machine learning models could enhance their precision in personalized diabetes risk prediction. In clinical settings, BRI and WHtR can be utilized as part of a tiered screening approach, where individuals exceeding risk thresholds are further evaluated with biochemical testing, thus optimizing resource use in large-scale screening programs.

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