
RESEARCH ARTICLE

Analysis of Waist-to-Hip and Height Ratio on the Risk of Cardiovascular Disease

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ABSTRACT

Cardiovascular disease (CVD) remains a major global health issue affecting people of all ages, including those in their prime of life. Even though there are several risk factors for CVD, prevention depends on early identification. Moreover, Waist-to-Hip Ratio (WHR) and Waist-to-Height Ratio (WHtR) are predictors of cardiovascular disease that are easy to do and can be used for early detection of CVD. The aim of this study was to analyze the relationship between WHR and WHtR with the risk of CVD in the productive age group. The study used a cross-sectional design and purposive sampling involving 150 respondents aged 25-64. WHR and WHtR measurements as predictors and CVD risk scores were calculated using the Jakarta Cardiovascular Score (JCS). This study was analyzed with the Spearman's Rho test. The majority of women's WHR increased with low CVD risk, the majority of men's WHR increased with high CVD risk, and the majority of WHtR in both men and women increased with low CVD risk. There is a relationship between WHR and the risk of CVD with JCS in productive age ($p=0.000$, $r = 0.535$) and a relationship between WHtR and the risk of CVD with JCS ($p=0.000$, $r = 0.332$). The study suggests that WHR and WHtR are significant measurements in cardiovascular assessment to prevent cardiovascular disease in the productive age group.

KEYWORDS

Cardiovascular Disease, Waist-to-Hip Ratio, Waist-to-Height Ratio

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1. Introduction

Cardiovascular disease (CVD) is a problem faced throughout the world. CVD prevalence nearly doubled from 271 million in 1990 to 523 million in 2019 (Kauffman, 2020). In the United States, the total CVD prevalence of both sexes aged ≥ 20 years old in 2015-2018 was 126.9 thousand (49.2%) (Virani et al., 2021). The Ministry of Health of the Republic of Indonesia (2018) reports showed that the prevalence of CVD based on a doctor's diagnosis in Indonesia is 1.5%. CVD contributes to health problems and excess health system costs (Vaduganathan, Mensah, Turco, Fuster, & Roth, 2022). More than half a billion people worldwide are affected by CVD (World Heart Federation, 2023). Not only does it cause health problems, CVD also caused around a third of all deaths globally in 2019 (Roth, Mensah, & Fuster, 2020). Apart from that, it also causes more than three quarters of deaths in low and middle income countries (WHO, 2021). Surveys show that the highest number of deaths from CVD occurs in China, followed by India, Russia, the United States and Indonesia (Roth et al., 2020). In 2020, the highest death rates from CVD occurred in Eastern Europe and Central Asia, with higher rates also seen in South and Southeast Asia (AHA, 2021). It indicates that CVD is a significant problem that needs to be addressed in order to prevent its detrimental effects.

CVD does not discriminate against gender, being the main cause of 9.6 million male deaths and 8.9 million female deaths (Roth et al., 2020). Based on geography, urban residents also experience more CVD. On the other hand, study results show that more than half of the rural population in Malaysia is at risk of CVD (Azahar, Krishnapillai, Hassan, Dasiman, & Yusoff, 2022). This shows that urban and rural communities are at risk of CVD. Currently, CVD is not only experienced by the elderly but is also experienced by people of productive age. As many as 6.1 million people from global deaths from CVD occurred at the age of 30-70 years (Roth et al., 2020).

Based on the Ministry of Health of the Republic of Indonesia (2018), the prevalence of CVD is more experienced by women, namely 1.6%, productive age (15-64 years) is 9.1%, and 1.6% are urban residents.

Risk factors for CVD include unhealthy lifestyle habits such as unhealthy eating habits, lack of physical activity, tobacco use and excessive alcohol consumption (WHO, 2023). An unhealthy lifestyle can result in increased blood pressure, blood glucose, blood lipids, overweight and obesity, which can lead to CVD. In Indonesia, smoking and unhealthy eating patterns are major contributors to CVD. Several other risk factors are related to physiology, such as hypertension, high blood cholesterol and high blood sugar or glucose, aging, income and urbanization (WHO, 2023).

Basically, most CVD can be prevented by addressing risk factors related to unhealthy behavior (WHO, 2021). Efforts that can be made, such as stopping using tobacco, reducing salt in food, consuming more fruit and vegetables, regular physical activity, and avoiding alcohol use, have been proven to reduce the risk of CVD (WHO, 2023). One of the efforts to reduce the risk factors for CVD is by detecting it as early as possible so that management with counseling and medication can begin (WHO, 2021). Unfortunately, the majority of people, including those of productive age in low- and middle-income countries, do not benefit from primary healthcare programs for the early detection and treatment of people at risk of CVD (WHO, 2021). In addition, there is a lack of access to effective and fair healthcare services that meet community needs. As a result, there is a delay in detecting the course of disease and death from CVD at a younger or more productive age (WHO, 2021).

Several predictors can be an early sign of the risk of developing CVD, such as measuring the Waist-to-Hip Ratio (WHR), Waist-to-Height Ratio (WHtR), and Body Mass Index (BMI). Research results show that there is a relationship between WHR and the risk of CVD and the incidence of Coronary Heart Disease (CHD) (Hastuti, Widigdo, Sarwono, & Supriyatno, 2022). WHtR measurements can also be used to predict the incidence of CVD in adults with hypertension and type 2 diabetes (Ke et al., 2022). WHtR can help predict hypertension and then reduce the incidence of CVD (Fajria, Triyanti, & Kusharisupeni, 2021; Zhang et al., 2022)

Likewise, the BMI value is related to increasing blood pressure as a risk factor for CVD (Andriyani et al., 2022). WHR measurement had the highest Area Under the Curve (AUC) value (0.711; sensitivity: 62.22%, specificity: 42.73%) in men, while WHtR showed the highest AUC value (0.751, sensitivity: 39.24%, specificity: 75.68%) in women (Wu et al., 2022). Meanwhile, WHtR has the best AUC, namely 0.769 in men and 0.756 in women (Fajria et al., 2021). Several studies show that WHR measurements have a more significant relationship with the incidence of CVD than BMI.

Basically, independent early detection of CVD is also provided by various platforms. However, a person's diagnosis of disease still requires further physical examination by a professional health worker. Several methods of assessing CVD risk can be carried out using the Framingham Risk Score (FRS), Globorisk score, China-PAR (Prediction of atherosclerotic CVD risk in China), and the Jakarta Cardiovascular Score (JCS) in Indonesia. Various studies abroad use FRS to predict the risk of CVD. WHR, hypertension, smoking, diabetes and high low-density lipoprotein (LDL) are the main predictors of high FRS scores (Azahar et al., 2022).

However, the study results showed that the risk estimates from the China-PAR model were all higher than the observed CVD event rates, and similarly, the FRS showed significant overestimation (Chen et al., 2023). Meanwhile, the use of the Globorisk score is usually due to its ability to evaluate a country's specific CVD risk (Adil et al., 2023). Although frequently used, assessing the risk of CVD using FRS is more complicated because it requires laboratory examination results such as total cholesterol values and High-Density Lipoprotein (HDL) cholesterol.

Generally, CVD risk scores are calculated using FRS even though JCS can also be used to assess CVD risk, and some are linked to WHR or WHtR predictors (Hastuti et al., 2022; Imania, 2022; Purwanti, Muntaha, & Sudaryanto, 2020). In comparison, measuring risk factors for heart disease with JCS is relatively easier to do. Assessment of the risk of CVD within 10 years with JCS can be assessed from gender, age, blood pressure, BMI, smoking habits, history of diabetes mellitus, and physical activity habits (Kusmana, 2002). Moreover, Indonesia, as a low resource setting, would benefit from the use of a tailored instrument that is relevant to the cultural context, thus increasing the cost-effectiveness of health expenditure. Previous research showed that JCS can be used to predict CVD in the next ten years based on various characteristics of respondents (Imania, 2022; Kusnandang, 2019; Purwanti et al., 2020). Therefore, this study wants to identify the relationship between WHR and WHtR with the level of CVD risk in the productive age group.

2. Methodology

According to WHO, the cut-off point for the risk of metabolic complications if the WHR in men is ≥ 0.90 cm and in women is ≥ 0.85 cm (World Health Organisation (WHO), 2008). The cut-off value for WHtR is 0.50 for males and 0.50 for females (Browning, Hsieh, & Ashwell, 2010). The instrument for assessing the risk of CVD in the next ten years uses the Jakarta Cardiovascular Score (JCS) with a sensitivity of 77.9%, specificity of 90%, and a predictive value of 92.2% (Kusmana, 2002). Interpretation of low risk if the JCS score is -7 to 1, moderate risk if the JCS score is 2-4, and high risk if the JCS score is ≥ 5 .

The inclusion criteria for respondents are 25-64 years old and able to work or produce something. The exclusion criteria were having a history of CVD, impaired physical mobility, pregnancy, and BMI >35.58. The sample size is calculated by using G*Power with parameter correlation 0.3, alpha 0.05, and power 0.95 required 138 samples. After an additional 10 % of missing data, 150 sample sizes were selected from those who worked in educational institutions and were used for the study analysis.

This study used a cross-sectional design. Sample collection was done by purposive sampling. Each respondent underwent an assessment and measurement including gender, age, blood pressure, BMI, smoking history, blood sugar at any time, and sports or physical activity habits. Blood pressure measurement using the Omron HEM-7143T1 digital tensimeter. BMI measurement is obtained from the ratio of height (kg) to body weight (m²). These measurement results become characteristics for assessing the level of CVD risk using JCS. Height measurement using a body height meter and digital scales. A history of diabetes mellitus was obtained from measuring blood sugar levels when using the Easytouch GCU glucometer. Measure waist and hip circumference to assess WHR and WHtR using a meter. The relationship between Waist-to-Hip Ratio, Waist-to-Height Ratio and Risk of Cardiovascular Disease was analyzed by Spearman's Rho test.

3. Results and Discussion

This research involved 150 respondents of productive age. The frequency distribution of respondent characteristics is presented in the following table:

Table 1. Distribution of Respondent Education (n=150)

Education	Frequency (%)
Basic	6 (4)
Middle	26 (17.3)
Higher	118 (78.7)

Table 1. Shows that the majority of respondents are highly educated (78.7%). The majority of respondents have higher education consisting of a Diploma, Undergraduate, Master's Degree, or Doctoral Degree. Basic education includes elementary school, Madrasah Ibtidaiyah, and junior high school or Madrasah Tsanawiyah. Middle schools include high schools, vocational high schools, and Madrasah Aliyah.

The majority of respondents in this study were highly educated (78.7%). Referring to the results of the 2018 Basic Health Research conducted by the Ministry of Health of the Republic of Indonesia (2018), the majority of people with higher education (2.1%) and primary education (1.8%) also have CVD. This can be influenced by several research results showing that there is a relationship between education level and risk factors and the incidence of CVD. According to the American Heart Association (AHA), education level is also known to influence a person's risk of developing CVD (AHA, 2019). Risk factors for CVD, such as hypertension, abnormal BMI, and diabetes, accounted for 26% of the relationship between education level and CVD incidence (Dégano et al., 2017). Individuals with a low level of education have a higher risk of CVD, such as heart attacks. A study showed that a low level of education was an independent predictor of poor outcomes in patients undergoing angiographic evaluation for coronary artery disease (Kelli et al., 2019).

Table 2. Based on Respondent Characteristics Risk Factors for CVD (n=150)

Risk Factors	Risk Level						Total	
	Low		Moderate		High			
Gender								
Female	50	33.33%	13	8.67%	5	3.33%	68	45.33%
Male	15	10%	27	18%	40	26.67%	82	54.67%
Age								
25-34	30	20%	12	8%	5	3.33%	47	31.33%
35-39	15	10%	6	4%	5	3.33%	26	13.33%
40-44	11	7.33%	11	7.33%	12	8%	34	22.66%
45-49	9	6%	7	4.67%	8	5.33%	24	16%
50-54	0	0%	4	2.67%	5	3.33%	9	6%
55-59	0	0%	0	0%	6	4%	6	4%
60-64	0	0%	0	0%	4	2.67%	4	2.67%
Blood Pressure								
Normal	53	35.33%	23	15.33%	11	7.33%	87	57.99%
High Normal	7	4.67%	11	7.33%	12	8%	30	20%
Grade 1 Hypertension	5	3.33%	5	3.33%	17	11.33%	27	17.99%

Grade 2 Hypertension	0	0%	1	0.67%	3	2%	4	2.67%
Grade 3 Hypertension	0	0%	0	0%	2	1.33%	2	1.33%
Body Massa Index								
13.79 – 25.99 kg/m ²	42	28%	19	12.67%	19	12.67%	80	53.33%
26.00 – 29.99 kg/m ²	18	12%	14	9.33%	16	10.67%	48	32%
30.00 – 35.58 kg/m ²	5	3.33%	7	4.67%	10	6.67%	22	14.66%
Smoking								
Never	61	40.66%	18	12%	9	6%	88	58.66%
Ex-smoker	0	0%	1	0.67%	4	2.67%	5	3.34%
Smoker	4	2.67%	21	14%	32	21.33%	57	38%
Diabetes Mellitus								
No	65	43.44%	40	26.67%	38	25.33%	143	95.33%
Yes	0	0%	0	0%	7	4.67%	7	4.67%
Exercise/ Physical Activity								
No	29	19.33%	24	16%	32	21.33%	85	56.67%
Low	25	16.67%	9	6%	9	6%	43	28.67%
Moderate	7	4.67%	7	4.67%	4	2.67%	18	12%
High	4	2.67%	0	0%	0	0%	4	2.67%

Table 2. shows that the majority of respondents are female with a low risk of CVD (33.33%). The majority are aged 25-34 years with a low risk of CVD (20%). The majority have normal blood pressure with a low risk of CVD (35.3%). Normal blood pressure is <130/85 mmHg, high normal is 130-139/85-89 mmHg, grade 1 hypertension is 140-159/90-99 mmHg, grade 2 hypertension is 160-179/100-109 mmHg, and hypertension grade 3, namely $\geq 180/\geq 110$ mmHg. The majority of BMI is 13.79-25.99 kg/m², with a low risk of CVD (28%). The majority have never smoked (40,66%), with a low risk of CVD. The majority of respondents did not have diabetes mellitus (43.44%), with a low risk of CVD. While the majority of respondents did not exercise/physical activity with a high risk of CVD (21.33%).

The WHO describes cardiovascular risk factors, which include underlying social, behavioral, and metabolic determinants and drivers (WHO, 2016). Social determinants and drivers such as globalization, urbanization, aging, income, education, and place of residence. Behavioral factors such as unhealthy eating patterns, tobacco use, harmful alcohol use, and lack of physical activity. While metabolic factors such as high blood pressure, obesity, high cholesterol levels, and high blood sugar levels or diabetes mellitus.

Several risk factors, such as hypertension, abnormal cholesterol levels, diabetes mellitus, and obesity, increase the occurrence of CVD (CDC, 2023b). Risk factors for CVD can be categorized into two groups, namely modifiable and non-modifiable risk factors. Modifiable risk factors for CVD include hypertension, hyperlipidemia, diabetes, obesity, smoking, poor diet, sedentary lifestyle or lack of physical activity, and stress (Brown, Gerhardt, & Kwon, 2023). Lifestyles that can increase the occurrence of CVD include high consumption of foods containing saturated fat, trans fat, cholesterol, and alcoholic beverages (CDC, 2023b). Risk factors for CVD that cannot be modified include age, gender, ethnicity, and family history of Coronary Heart Disease (CHD) (Brown et al., 2023).

The majority of respondents in this study were female, with a low risk of CVD (33.33%). However, for male respondents, the majority had a high risk of CVD (26.67%). The incidence of CVD in women is usually lower than that of men, but women have a higher mortality rate and a poorer prognosis after an acute cardiovascular event (Gao, Chen, Sun, & Deng, 2019). The lower risk of CVD in women can be influenced by adopting a healthier lifestyle compared to men. Primary prevention strategies, such as implementing several healthy lifestyle behaviors and using a medication, are more common in women than men (Walli-Attaei et al., 2020). Therefore, gender is a variable that is considered to be added to the CVD risk assessment so that disease prevention is better (Gao et al., 2019).

The majority of respondents were aged 25-34 years with a low risk of CVD (20%). The prevalence of heart disease in Indonesia based on age 25-34 years is 0.8%, and the number increases with age. Age is an independent risk factor for CVD and can be exacerbated by other factors (Rodgers et al., 2019). CVD has a significant correlation with age but varies by sex (Gao et al., 2019). CVD can occur in all age groups, and the risk increases with age, but becoming more common in young adults because risk factors or conditions that cause heart disease occur at younger ages (Gao et al., 2019; Kelli et al., 2019). In men, the risk profile for CVD increases linearly with age, and the atherosclerotic process continues to progress, but in women, the risk increases after menopause (Gao et al., 2019).

The majority of respondents had normal blood pressure with a low risk of CVD (35.3%). However, there were also respondents with normal blood pressure who had a moderate risk of CVD (15.33%) and grade 1 hypertension with a high risk of CDV (11.33%). Measuring systolic blood pressure can be an early detection effort for CVD, such as CHD (Sudikno & Tuminah, 2020). This is related to blood pressure as the main risk factor for CVD (CDC, 2023b). High rates of obesity and high blood pressure among young people (35-64 years) place this age group at risk for CVD at an early age (CDC, 2023a).

The majority of respondents had a BMI in the range of 13.79-25.99 kg/m² or within normal limits, with a low risk of CVD (28%). However, there are also respondents with a BMI of 30.00 – 35.58 kg/m² who have a high risk of CVD (6.67%). BMI is a measurement method that compares weight to height. BMI measurement to assess obesity in general without taking into account the distribution of fat around the waist and hips. BMI is a measure of general adiposity and does not differentiate between adipose tissue present in the visceral and subcutaneous areas (Peters, Bots, & Woodward, 2018).

Previous studies have shown that the risk of CVD is higher in middle-aged adults who are overweight and obese (Khan et al., 2018). Individuals who are obese have a hazard ratio of 3.26 for heart failure and a hazard risk of 3.31 for death related to CVD (Iyen et al., 2021). Underweight with a BMI <20 kg/m² and a very high BMI ≥35 kg/m² are strong risk markers for poor prognosis in CHD patients (Held et al., 2022).

The majority of respondents have never smoked, with a low risk of CVD (40.66%). However, there are also respondents who smoke with a high risk of CVD (21.33%). Based on the Ministry of Health of the Republic of Indonesia (2018), the prevalence of daily smokers in Indonesia in the population aged 10-18 years is 9.1% and is increasing. Smoking habits can damage the heart and blood vessels. The nicotine content in cigarettes can increase blood pressure, and carbon monoxide from cigarette smoke reduces the amount of oxygen carried by the blood, thereby increasing the risk of heart diseases such as atherosclerosis and heart attack (CDC, 2023b).

Based on random blood sugar measurements, the majority of respondents did not experience diabetes mellitus with low risk factors for CVD (43.44%). However, there were respondents who did not have diabetes mellitus with moderate risk (26.67%) and high risk of CVD (25.33%). This is thought to be due to the presence of respondents with other risk factors who have a moderate and high risk of experiencing CVD. Similar research also shows that hypertension, smoking and diabetes are the main predictors of a high risk of CVD using The FRS (Azahar et al., 2022).

The majority of respondents do not exercise or do physical activity at high risk of experiencing CVD (21.33%). Lack of physical activity can increase the likelihood of developing other medical conditions that are risk factors, including obesity, high blood pressure, high cholesterol, and diabetes (CDC, 2023b). However, low physical activity and prolonged sitting time are risk factors for CVD in people with a sedentary lifestyle that can be changed (Alquaiz, Siddiqui, Kazi, Batais, & Al-Hazmi, 2019).

Basically, CVD can be prevented by modifying risk factors. Implementation of population-based CVD prevention strategies to reduce the level of risk factors, especially blood pressure, total cholesterol, and smoking prevalence, can reduce the increasing burden of CVD in Indonesia (Hussain, Mamun, Peters, Woodward, & Huxley, 2016). Individuals who adopt a healthy lifestyle with regular physical activity, good nutrition, weight management, and not smoking have been proven to reduce the risk of CVD by >80% (Rippe, 2019). The conclusion is that CVD can be screened for identification and treated early (Brown et al., 2023).

Table 3. Relationship of WHR and WHtR to the Risk of CVD

Risk Factor	Risk Level						Total	p-value	r
	Low		Moderate		High				
WHR									
Female									
Normal	20	13.33%	0	0%	2	1.33%	22 (14.67%)	0.000	0.535
Elevated	30	20%	13	8.67%	3	2%	46 (30.67%)		
Male									
Normal	9	6%	10	6.67%	5	3.33%	24 (16%)	0.000	0.332
Elevated	6	4%	17	11.33%	35	23.33%	58 (38.67%)		
WHtR									
Normal	25	16.67%	6	4%	9	6%	40 (26.67%)	0.000	0.332
Elevated	40	26.67%	34	22.67%	36	24%	110 (73.33%)		
Total	65	43.33%	40	27.67%	45	30%	150 (100%)		

Table 3. shows that the majority of female WHR increased with low CVD risk (20%), the majority of male WHR increased with high CVD risk (23.33%), and the majority of WHtR increased with low CVD risk in both sexes (26.67%). Based on bivariate analysis with the Spearman's Rho test, it showed that the relationship between WHR and the risk of CVD at reproductive age was $p = 0.000$ and $r = 0.535$. Meanwhile, the relationship between WHtR and the risk of CVD at productive age was $p=0.000$ and $r=0.332$.

The majority of female respondents' WHR increased with a low risk of CVD (20%). This could be due to other factors that reduce the CVD risk score based on the JCS, such as female gender, young age, blood pressure and BMI within normal limits. The CVD risk score was also low because the majority of female respondents did not have diabetes mellitus, even though the majority did not exercise or do physical activity.

Meanwhile, the majority of male respondents had an increased WHR with a high risk of CVD (23.33%). Factors that increase the risk score of CVD in men in this study are gender, blood pressure, BMI, smoking, and not exercising. A study shows that risk factors such as age, hypertension, total cholesterol and LDL cholesterol have a big influence on men (Gao et al., 2019). Basically, both men and women of productive age can try to reduce risk factors for CVD by adopting a healthier lifestyle. In contrast to the elderly, the process of decreasing body function occurs, thereby increasing the risk of CVD. Increasing age is also associated with a decrease in overall sex hormones, especially estrogen and testosterone, which have a relationship with the cardiovascular system (Rodgers et al., 2019).

In this study, the results of bivariate analysis using Spearman's Rho test showed a relationship between WHR and the risk of CVD using JCS in the productive age group ($p=0.000$). The level of relationship between WHR and the risk of CVD using JCS is $r=0.535$, which means a moderate positive relationship. A positive relationship can be interpreted as meaning that the higher a person's WHR, the higher the risk of experiencing CVD. The results of this study are in line with previous research, which also saw a significant relationship between WHR and the risk of CVD ($p < 0.001$ and $r = 0.385$) (Hastuti et al., 2022). Similar research also shows that WHR is the main predictor of high risk of CVD using FRS (Azahar et al., 2022). WHR is also more strongly associated with the risk of myocardial infarction than BMI, especially in women and blood pressure with a test power of 0.526 (Ke et al., 2022; Rodgers et al., 2019).

WHR is the ratio of waist to hip circumference, which can describe the excess accumulation of intra-abdominal adipose tissue or visceral obesity. Fat around the waist is more metabolically active than fat on the hips because it is closely related to insulin resistance. The most common functional subunits of adipose tissue, the white and brown adipocytes, regulate and respond to endocrine processes, which in turn determine the metabolic rate and function of adipose tissue. (Valencak, Osterrieder, & Schulz, 2017). Physiological characteristics of abdominal adipose tissue, such as adipocyte size and number, lipolytic response, lipid storage capacity, and inflammatory cytokine production, are significant correlates and determinants of the increased cardiometabolic risk associated with visceral obesity (Tchernof & Després, 2013).

Therefore, central adipose measures such as the WHR may be associated with CVD risk (AHA, 2018). WHR measurements also show sex dimorphism in the quantity and distribution of adipose tissue that results in differences in body shape between genders and may have different implications for future CVD risk (Peters et al., 2018). However, modifiable risk factors such as central obesity have strong implications for primary prevention and treatment services that can change the risk profile of a population (Alquaziz et al., 2019).

The results of this study also showed that the majority of WHtR increased with a low risk of CVD (26.67%). However, there are also respondents who have an increased WHtR with a high risk of CVD (24%). This could be because, in the productive age group, factors such as blood pressure, BMI, smoking history and exercise can show very varied results, thus influencing the risk score for CVD.

The results of the Spearman's Rho test analysis in this study showed that there was a relationship between WHtR and the risk of CVD in the productive age group ($p=0.000$, $r=0.332$). The association level $r=0.332$ indicates a weak positive association between WHtR and the risk of CVD. A positive relationship can be interpreted as meaning that the higher a person's WHtR, the higher the risk of experiencing CVD. In this study, the level of association between WHtR and CVD risk events was lower than the association level with WHR.

However, the results of other studies show that WHtR is considered more sensitive than waist circumference because it can adjust to the varying heights of each person (Ashwell & Hsieh, 2005). In two individuals with the same BMI, the amount of body fat in the short posture is greater than in the tall posture (López-Alvarenga, Montesinos-Cabrera, Velázquez-Alva, & González-Barranco, 2003). Someone with a similar waist circumference may have a different body fat percentage if they are of different heights (Moosaie et al., 2021). Therefore, WHtR measurement can be a good predictor because it can provide an appropriate picture of

body fat composition based on each person's height and waist circumference. The WHtR calculation also does not require certain characteristic limits and has clear recommended limit values so that it can be simplified into advice to the public to keep waist circumference less than half of body height (Browning et al., 2010). In certain populations, measuring WHtR is also easier because it measures stable body height (Fajria et al., 2021).

The WHtR can also show better predictive value for cardiovascular disease events compared to other predictors such as BMI, waist circumference, and WHR (Browning et al., 2010; Zhang et al., 2022). This is in line with previous research, which shows that WHtR has a positive relationship with the incidence of CVD and can be the best alternative for predicting hypertension in adulthood (Fajria et al., 2021; Moosaie et al., 2021; Zhang et al., 2022).

4. Conclusion

The aim of this study was to examine the association between waist-to-hip ratio (WHR) and waist-to-height ratio (WHtR) with the risk of cardiovascular disease (CVD) among individuals in the productive age bracket. A moderate positive correlation has been observed between WHR and the likelihood of CVD. Furthermore, a modest positive correlation was observed between WHtR and susceptibility to CVD. Therefore, both WHR and WHtR might serve as effective and straightforward preliminary measures for evaluating the susceptibility to CVD, particularly among individuals in their prime years of productivity. Monitoring WHR and WHtR can be effective strategies for the productive age group to mitigate the risk and proactively prevent the onset of CVD in the future. Nevertheless, this study solely focused on investigating the association between WHR and WHtR in connection to the risk of CVD. The findings' generalizability to other age groups is limited. Future study has the potential to examine additional determinants of CVD within other demographic groups.

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