

WAIST TO HIP RATIO IN CARDIOVASCULAR DISEASE RISK: A REVIEW OF THE LITERATURE

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ABSTRACT

The World Health Organisation (WHO) defines obesity and overweight as a medical condition characterized by the abnormal accumulation of fat. While body mass index (BMI) is commonly used to measure obesity, it has limitations in accounting for differences in body fat distribution. The aim of this study is to compare the effects of body mass index and waist-to-hip ratio on the likelihood of developing cardiovascular disease. Various search methods, including indexed sources from Google Scholar, were used to access a diverse range of literature published in the last ten years. The review employed deductive and inductive reasoning to compile and extract relevant information. Deductive reasoning was used to establish a theoretical framework and identify concepts related to waist-to-hip ratio (WHR) and cardiovascular disease (CVD). Inductive reasoning was then applied to analyse the literature and draw conclusions based on the accumulated evidence. The study found that waist-to-hip ratio is a valuable indicator of cardiovascular disease risk in people of all ages, regardless of their body mass index. It is particularly useful when other metabolic risk factors such as diabetes, lipoprotein abnormalities, smoking, and hypertension are present. This approach is especially beneficial for identifying patients who may be at risk of cardiovascular disease despite having a normal BMI. Waist-to-hip ratio provides additional insights into central adiposity, which has been linked to various metabolic abnormalities and an increased risk of cardiovascular disease.

Keywords: Obesity, Waist-to-Hip Ratio, Body Mass Index, Central Adiposity, Cardiovascular Risk

INTRODUCTION

The World Health Organisation (WHO) defines obesity and overweight as a medical condition characterized by abnormal or excessive accumulation of fat. Obesity usually arises from a complex interplay of genetic and environmental factors like culture, socioeconomic status, and lifestyle, leading to a significant public health issue in the modern era. In adults, overweight and obesity are commonly classified using the body mass index (BMI), which is calculated by dividing body weight in kilograms by the square of height in meters. Current guidelines by WHO define a healthy BMI as falling between 18.5 and 22.9, while a BMI of 23 kg/m² is considered overweight, 25 kg/m² is classified as obese, and 30 kg/m² is categorized as morbidly obese. Over the past two decades, the global prevalence of overweight and obesity has risen substantially, primarily due to changes in socioeconomic factors and lifestyle patterns, characterized by reduced physical activity and increased consumption of energy-dense foods, especially refined carbohydrates. Untreated obesity has detrimental effects on all bodily functions, reduces quality of life, and raises the risk of diseases and healthcare burden worldwide. (Panuganti et al., 2023; Soeroto et al., 2020)

Obesity is a significant health issue, and while body mass index (BMI) is commonly used to measure it, it has limitations in accounting for variations in body fat distribution. It's important to note that many individuals with a normal BMI can still have excessive amounts of visceral fat, which poses metabolic risks. In terms of metabolic impact, the distribution of body fat carries more importance than overall body weight or BMI

alone. Excessive visceral fat, which accumulates around the abdominal organs, is associated with an increased risk of various health conditions, including cardiovascular disease, type 2 diabetes, and metabolic syndrome. This underscores the need to consider fat distribution and specifically assess visceral fat levels. While BMI is a useful tool for evaluating overall weight status, it doesn't provide insights into the distribution of body fat. Therefore, relying solely on BMI may not fully capture the metabolic implications associated with excessive visceral fat. To gain a more accurate understanding of fat distribution, additional measures such as waist circumference, waist-to-hip ratio, or imaging techniques like computed tomography (CT) or magnetic resonance imaging (MRI) are recommended. These approaches can help identify individuals who may be at higher metabolic risk despite having a normal BMI. Addressing the health concerns related to obesity requires a comprehensive approach that takes into account not only body weight or BMI but also the distribution of body fat, particularly visceral fat. By adopting this comprehensive perspective, healthcare professionals can better identify individuals who may benefit from targeted interventions and ongoing monitoring to mitigate the metabolic risks associated with excessive visceral fat levels. (Jokinen, 2015; Ng et al., 2020)

Obesity poses a significant threat to cardiovascular health and is linked to higher mortality rates. Over the past twenty years, the prevalence of obesity in the United States has surged, with approximately 30% of American adults, or more than 60 million

individuals, classified as obese, according to the National Center for Health Statistics. Obesity plays a role in the development and progression of various conditions, including metabolic syndrome, characterized by a cluster of risk factors such as abdominal obesity, high blood pressure, elevated blood sugar, and abnormal cholesterol levels. Detecting and diagnosing these conditions at an early stage is crucial for implementing appropriate interventions and preventing further complications. Healthcare professionals can prioritize early detection and intervention strategies by recognizing obesity as a significant risk factor. This entails screening individuals for obesity and related metabolic abnormalities like high blood pressure, glucose intolerance, and dyslipidaemia. Prompt identification and targeted management of obesity and its associated conditions can substantially reduce the incidence and progression of cardiovascular disease and metabolic syndrome. Raising awareness and implementing preventive measures are vital in combating the obesity epidemic and alleviating the burden of cardiovascular disease-related mortality. Encouraging individuals to maintain a healthy weight, adopt a balanced diet, engage in regular physical activity, and undergo routine health check-ups can contribute to early identification and management of obesity-related risks, ultimately leading to improved overall health outcomes. (Jokinen, 2015; Mitchell et al., 2011)

Cardiovascular disease (CVD), which includes conditions such as ischemic heart disease and stroke, is a leading cause of morbidity and mortality worldwide. Over the past few decades, the global prevalence

of CVD has witnessed a substantial escalation, with the number of affected individuals soaring from 271 million in 1990 to 523 million in 2019. Likewise, CVD-related deaths have experienced a significant upsurge, rising from 12.1 million in 1990 to 18.6 million in 2019. Despite advancements in secondary preventive and rehabilitative treatments, CVD continues to impose a substantial burden on global health. In light of its profound impact, prioritizing primary prevention strategies is paramount in mitigating the burden of CVD. (Roth et al., 2020)

Anthropometric assessments provide a convenient, cost-effective, and reliable means to evaluate abdominal obesity, a significant contributor to heightened cardiovascular disease (CVD) risk. Measures such as body mass index (BMI), waist circumference (WC), waist-to-hip ratio (WHR), and waist-to-height ratio (WHtR) are frequently utilized in epidemiological and clinical research to quantify abdominal obesity and its association with the accumulation of visceral fat. Particularly, waist circumference (WC) and waist-to-hip ratio (WHR) have emerged as prevalent tools for examining the presence of abdominal obesity and its relationship with visceral fat distribution. (Powell-Wiley et al., 2021; Roth et al., 2020)

Anthropometry tests offer valuable insights into body composition and fat distribution. They help identify individuals at a higher risk of CVD due to excessive abdominal fat accumulation. By incorporating these measurements into research studies and clinical practice, healthcare professionals can better understand the relationship between abdominal obesity and CVD risk. The use of

anthropometry measurements like WC and WHR aids in identifying individuals who may benefit from targeted interventions aimed at reducing abdominal obesity and mitigating CVD risk. These simple and practical measurements serve as important tools for both research and clinical settings, enabling the identification and monitoring of abdominal obesity and its impact on cardiovascular health. (Piqueras et al., 2021; Powell-Wiley et al., 2021)

While BMI, WC, WHR, and WHtR are all anthropometric measurements that can indicate obesity and have been associated with cardiovascular disease (CVD) outcomes, there are important considerations to keep in mind when utilizing these indices. Specifically, WHR is often regarded as a more accurate reflection of abdominal obesity, particularly in individuals with larger body measurements. In cases where individuals have higher body mass but lack abdominal obesity, the waist circumference measurement alone may be misleading, as it takes into account overall body size and may not solely reflect abdominal fat accumulation. This can lead to potential misclassification or confusion. (Fang et al., 2018; Roth et al., 2020) To address this issue, WHR is commonly used as an alternative measurement for assessing abdominal obesity. WHR focuses on the ratio between waist circumference and hip circumference, accounting for differences in body size and providing a more precise evaluation of abdominal fat distribution. By incorporating WHR as an indicator of abdominal obesity, researchers and healthcare professionals can obtain a more accurate assessment of the risk associated with excess abdominal fat and its impact on cardiovascular health. Early

detection of abdominal obesity and related conditions is crucial for effective prevention and management. By utilizing WHR as a measure of abdominal obesity, healthcare providers can enhance their ability to identify individuals at risk and implement appropriate preventive measures, leading to improved outcomes in terms of CVD prevention and management.

LITERATURE REVIEW

Abdominal Obesity

Abdominal obesity is widely recognized as a significant risk factor for cardiovascular disease (CVD). While body mass index (BMI) is commonly used to assess overall obesity, anthropometric measures specifically targeting abdominal obesity, such as waist circumference (WC), waist-to-hip ratio (WHR), and sagittal abdominal diameter, have shown stronger associations with metabolic risk factors, incident CVD events, and mortality. (Jokinen, 2015) The detrimental effects of abdominal obesity on cardiovascular and metabolic health can be attributed to visceral adipose tissue (VAT), which is found around organs in the abdominal cavity. VAT is metabolically active and releases various substances that contribute to insulin resistance, dyslipidaemia (abnormal lipid levels), and hypertension. These metabolic abnormalities significantly increase the risk of developing cardiovascular diseases. One of the key concerns is the production of pro-inflammatory substances, such as cytokines and adipokines, which promote systemic inflammation and oxidative stress. These factors contribute to the development of atherosclerosis, the formation of plaque within the arteries, leading to reduced blood flow and increased

risk of cardiovascular disease. Additionally, visceral adipose tissue is metabolically active and releases excess free fatty acids into the bloodstream, contributing to insulin resistance, dyslipidemia, and high blood pressure, all of which are major risk factors for heart disease. (Mittal, 2019; Shuster et al., 2012)

While advanced imaging techniques like computerized axial tomography (CAT), magnetic resonance imaging (MRI), and dual-energy x-ray absorptiometry (DXA) can accurately measure VAT, they are impractical and costly for routine clinical use. Therefore, anthropometric measures such as WC, WHR, and sagittal abdominal diameter are more feasible and cost-effective alternatives for assessing abdominal obesity and estimating associated CVD risk. These measures provide a practical way to evaluate the distribution of fat in the abdominal area and can help identify individuals at higher risk of developing cardiovascular complications. By considering these anthropometric measures, healthcare professionals can assess abdominal obesity-related risks more effectively and implement appropriate interventions to reduce CVD risk factors in affected individuals. (Taylor et al., 2021)

Waist circumference (WC) and waist-to-hip ratio (WHR) are commonly used as substitute metrics for visceral adipose tissue (VAT), a key component of abdominal obesity. Both WC and WHR are correlated with VAT, although the correlation between WC and VAT tends to be stronger. While WC is more strongly correlated with VAT, WHR may be a more accurate predictor of cardiovascular disease (CVD) risk due to the additional consideration of hip circumference. The inverse

association between hip circumference and the development of cardio-metabolic risk factors and CVD is thought to contribute to the predictive value of WHR. A higher hip circumference is associated with a more favourable metabolic profile, including lower insulin resistance, improved lipid levels, and reduced risk of CVD. (Ahmad et al., 2016; Jokinen, 2015)

By incorporating both waist and hip measurements, WHR captures the balance between abdominal and gluteal fat distribution, which may provide additional insights into an individual's risk of developing CVD. This combination of measurements takes into account the potential protective effect of hip circumference on cardiometabolic health. While WC is a simpler and more direct measure of abdominal obesity, WHR provides a more comprehensive assessment by considering the relative proportions of waist and hip circumferences. Healthcare professionals may consider using WHR as a valuable tool for assessing CVD risk, as it takes into account both abdominal fat accumulation and the potentially protective effects of gluteal fat distribution. (Ahmad et al., 2016; Shuster et al., 2012).

Waist Circumference

The measurement of waist circumference (WC) involves identifying the smallest circumference between the lower ribcage and iliac crests, which allows for an evaluation of adipose tissue accumulation in the abdominal region. In contrast, hip circumference is determined by locating the widest circumference between the iliac crest and quadriceps, typically at the point of maximal gluteal muscle protrusion. By dividing the waist circumference

by the hip circumference, the waist-to-hip ratio (WHR) is derived. This ratio serves as a valuable indicator of how adipose tissue is distributed between the abdomen and thighs, providing valuable insights into the patterns of fat deposition in the body. (Bastien et al., 2014; Powell-Wiley et al., 2021)

The measurement of waist circumference has become a reliable way to assess abdominal obesity and has shown strong associations with cardiovascular disease. Excessive fat buildup around the waist, known as central or visceral obesity, has negative impacts on heart health. People with larger waist circumferences often have higher levels of metabolically active visceral fat, which releases inflammatory substances and hormones. This process triggers chronic low-level inflammation, insulin resistance, and abnormal lipid levels. These factors collectively promote the development of atherosclerosis, the build-up of plaque in the arteries, thus elevating the risks of heart disease, heart attacks, and strokes.

Moreover, central obesity is linked to several additional cardiovascular risk factors. Individuals with a larger waist circumference often experience high blood pressure, impaired glucose metabolism, and abnormalities in their lipid profiles, such as high cholesterol or triglyceride levels. These risk factors compound the likelihood of developing cardiovascular disease and can result in long-term complications if left unaddressed. Therefore, closely monitoring and proactively managing waist circumference through lifestyle modifications are essential measures for mitigating the risk of cardiovascular disease.

These measurements, namely WC and WHR, can be valuable for assessing cardiovascular disease (CVD) risk in individuals of all ages, regardless of their body mass index (BMI). They are particularly useful when other metabolic risk factors such as diabetes, lipoprotein abnormalities, smoking, and hypertension are present. By considering WC and WHR in conjunction with other risk factors, healthcare professionals can gain a comprehensive understanding of an individual's CVD risk profile. These measurements provide insights into the distribution of body fat, which is relevant for assessing metabolic health and the potential risks associated with excess abdominal adiposity.

METHOD

This literature review focuses on investigating the association between waist-to-hip ratio (WHR) and the risk of cardiovascular disease (CVD). The study incorporates a wide range of secondary and tertiary sources, including scientific journals, books, dictionaries, and encyclopaedias, to gather relevant information. The research relies on various search methods, including indexed sources from Google Scholar, to access a diverse selection of literature published within the past decade.

To compile and extract relevant literature, the review employs a combination of deductive and inductive mechanisms. Deductive reasoning is employed to establish a theoretical framework and identify relevant concepts related to WHR and CVD. Inductive reasoning is then used to analyse the available literature and draw conclusions based on the accumulated evidence.

Through the utilization of comprehensive sources and systematic search methods, this journal article aims to delve deeply into the link between waist-to-hip ratio (WHR) and the risk of cardiovascular disease (CVD). By incorporating a broad range of reliable sources, the study seeks to conduct a thorough investigation and provide an in-depth analysis of

the topic. The review will encompass recent and credible research findings, enabling a comprehensive examination of the association between WHR and CVD risk. The article endeavours to offer valuable insights that contribute to our understanding of how WHR influences the development and progression of CVD.

RESULT AND DISCUSSION

Waist to Hip Ratio

Utilizing waist-to-hip ratio instead of BMI as a means of gauging obesity and the associated risk of cardiovascular disease (CVD) has a notable effect on the proportion of individuals identified as being susceptible to myocardial infarction. According to researchers, establishing a waist-to-hip ratio threshold of 0.83 for females and 0.9 for males would triple the population-attributable risk for myocardial infarction. This holds particular significance in areas like Asia, where BMI measurements indicate limited obesity concerns, but employing waist-to-hip ratio would reveal a substantially elevated cardiovascular risk. (Heng & Chew, 2020)

Individuals who have a high waist-to-hip ratio (WHR), indicating an "apple" body shape with excess

weight concentrated in the abdominal area, are at a heightened risk of certain health conditions compared to those with a "pear" body shape characterized by wider hips. Research suggests that individuals with an apple-shaped body face a higher risk of obesity-related conditions such as cardiovascular disease and type 2 diabetes. It is noteworthy that even if other measures of obesity, like body mass index (BMI), fall within the normal range, a high WHR can still pose health risks. To evaluate the risk associated with WHR, the World Health Organization (WHO) recommends a WHR of 0.85 or lower for women and 0.90 or lower for men. These guidelines aim to promote a healthy waist-to-hip ratio and minimize the potential health risks linked to excessive abdominal fat. (Medina-Inojosa et al., 2018; Morris, 2017) (Table 1)

Table 1. Waist-To-Hip Ratio Interpretations

Men	Women	Risk Level
Less than 0,90	Less than 0,85	Low risk of metabolic complications
Between 0,90 and 0,95	Between 0,85 and 0,90	Moderate risk of metabolic complications like diabetes, heart disease, stroke, etc
Above 0,95	Above 0,90	High risk of metabolic complications like diabetes, heart disease, stroke, etc

Egeland et al. conducted a study involving 140,790 participants over a period of 9 years. The researchers found that after adjusting for other factors, waist-to-hip ratio (WHR) emerged as a significant predictor of Myocardial Infarction (MI) among both men and women who did not have an enlarged waist circumference (defined as 102 cm for men and 88 cm for women). This suggests that WHR is a more accurate indicator of MI risk in middle-aged adults compared to conventional risk factors such as BMI or an enlarged waist circumference. In a separate study by Horvei et al., which followed 6,379 subjects for an average of 15.7 years, it was found that WHR and waist-to-height ratio (WHtR) yielded the highest risk estimates for MI when compared to waist circumference and hip circumference. These findings hold important implications for identifying individuals at a high risk of MI and for predicting the prevalence of obesity within populations. Overall, these studies highlight the value of considering WHR and WHtR as superior predictors of MI risk and emphasize the potential benefits of using these measurements to enhance risk assessment and obesity prevalence estimation. (Egeland et al., 2016; Horvei et al., 2014)

DISCUSSION

Central obesity, characterized by a high waist-to-hip ratio (WHR), is believed to contribute to cardiovascular disease (CVD) through various mechanisms involving oxidative stress and inflammation, steroid hormones, free fatty acids, and altered production and function of hormones derived from adipocytes. Recent studies using cardiac metabolism imaging in large cohorts

have shown that excessive accumulation of visceral fat can exceed its storage capacity, leading to an overflow of lipids that are then stored in normally lean tissues such as the heart, liver, and intrathoracic fat. This abnormal lipid storage significantly contributes to cardiac and metabolic abnormalities. Additionally, fat cells in adipose tissue play a role in promoting processes related to atherosclerosis. Increased visceral fat is associated with insulin resistance, hypertriglyceridemia, the presence of highly atherogenic small LDL particles, and low levels of HDL, all of which are factors that promote the development of atherosclerosis. Consequently, these conditions induce endothelial vasomotor dysfunction, a state of increased blood coagulation, and dyslipidaemia, ultimately leading to the development of cardiovascular disease. In summary, central obesity, characterized by a high WHR, contributes to CVD through multiple pathways involving oxidative stress, inflammation, hormone imbalance, and abnormal lipid storage. These processes lead to various metabolic abnormalities and proatherogenic factors, resulting in endothelial dysfunction, coagulation abnormalities, and dyslipidaemia, ultimately increasing the risk of developing cardiovascular disease. (Bastien et al., 2014; Powell-Wiley et al., 2021)

These findings emphasize the importance of considering waist-to-hip ratio (WHR) as a crucial factor in predicting the risk of cardiovascular disease (CVD). Healthcare providers should take into account the central role of WHR when identifying populations. Further research is necessary to establish guidelines that effectively capture the various aspects of WHR

contributing to CVD risk. It is essential to include the potential risk associated with a high WHR in patient health education. Patients need to be informed that even if their body weight falls within a normal range, they may still be at risk due to abdominal obesity. This knowledge will enable individuals to take necessary precautions and make informed decisions about their health. Moreover, the study presents a new challenge for medical rehabilitation professionals who monitor physical activity in obese patients. Instead of solely focusing on body mass index (BMI), professionals should give increased attention to WHR as a more clinically relevant index of central obesity. By prioritizing WHR, healthcare providers can better mitigate the risk of morbidity at the onset of disease. In conclusion, the study underscores the significance of WHR in predicting CVD risk. Healthcare personnel should consider WHR as a primary factor in identifying at-risk populations, additional research is needed to establish comprehensive guidelines, patients should be educated about the implications of a high WHR, and medical professionals should prioritize WHR over BMI in monitoring the health of obese patients. (Bastien et al., 2014; Panuganti et al., 2023)

Gelber's study analysed self-reported anthropometric indices (BMI, WC, WHR, and waist-to-height ratio [WHtR]) in a large population from the Physician's Health Study and the Women's Health Study, and found that all four indices had positive associations with cardiovascular disease (CVD) risk. The strength of these associations was similar across the measures, but slightly diminished after accounting for BMI. For instance, men with a WHtR of 0.69 had a

hazard ratio of 2.36 compared to those with a WHtR between 0.49 and 0.53, and this decreased to 1.73 after adjusting for BMI. Similar results were observed when BMI was added to WC, indicating that BMI mediates a portion of the risk associated with central adiposity. While WHtR showed a slightly stronger association with CVD risk than BMI, the actual difference between the measures was small and not likely to have clinical significance according to the study's findings. It is important to note that these results contradict those of the INTERHEART study. In contrast to the findings of Gelber et al. in 2008, the INTERHEART study reported that waist-to-hip ratio (WHR) is more strongly associated with cardiovascular risk compared to body mass index (BMI) or waist circumference (WC). The divergent findings may be attributed to differences in study design, population characteristics, and measurement methods. Further research is necessary to reconcile these contradictory findings and gain a better understanding of the relationship between anthropometric indices and CVD risk. (Cao et al., 2018; Gelber et al., 2008)

In a meta-analysis conducted by De Koning et al. in 2007, the association between waist circumference (WC) and/or waist-to-hip ratio (WHR) and cardiovascular outcomes was examined. The analysis included 15 cohort studies with data on over 250,000 individuals and a total of 4,355 cardiovascular disease (CVD) events. Among these cohorts, eight reported on the association between both WHR and WC with coronary heart disease (CHD), four reported on WHR alone and CVD (including stroke or CHD), and three reported on WC alone and various

CVD outcomes. In a model that made minimal adjustments, the findings indicated that a 10% increase in CVD risk was associated with a 5% increase in WC and a 0.02 unit increase in WHR. These results suggest that both WC and WHR are positively correlated with the risk of developing CVD, with a slight difference in the magnitude of their associations. It is worth noting that this meta-analysis provides valuable insights into the relationship between WC, WHR, and CVD outcomes by synthesizing data from multiple studies. However, further research is necessary to investigate the specific mechanisms underlying these associations and to consider additional factors that may influence CVD risk. The findings from the study indicate that there is a clear association between measures of central adiposity and cardiovascular disease (CVD) risk. In both men and women, a 1 cm increase in waist circumference was associated with a 2% increase in incident CVD risk, while a 0.01 unit increase in waist-to-hip ratio was associated with a 5% increase in CVD risk. (Cao et al., 2018; de Koning et al., 2007)

CONCLUSION

The studies consistently demonstrate that waist-to-hip ratio (WHR) is a strong predictor of cardiovascular disease (CVD) risk. Individuals with a high WHR are at a significantly elevated risk of developing CVD. Importantly, this predictive effect of WHR is particularly pronounced in women compared to men. Therefore, measuring WHR may provide valuable clinical utility in assessing CVD risk, especially in cases where WHR indicates a higher risk than body mass index (BMI) alone.

By considering WHR as a complementary measure alongside BMI, healthcare professionals can obtain a more comprehensive assessment of a patient's cardiovascular risk profile. This approach can be especially beneficial for identifying patients who may be at risk despite having a normal BMI. WHR offers additional insights into central adiposity, which has been linked to various metabolic abnormalities and increased CVD risk. The World Health Organization (WHO) guidelines propose maintaining a waist-to-hip ratio (WHR) of 0.85 or lower for women and 0.90 or lower for men, with the intention of fostering a healthy waist-to-hip ratio and reducing the associated health risks connected to excessive abdominal fat. These guidelines are designed to encourage individuals to achieve and maintain a favourable waist-to-hip ratio, as it is considered indicative of a healthier body composition and can help minimize the likelihood of developing health conditions associated with excessive abdominal adiposity. By adhering to these guidelines, individuals can actively manage their waist-to-hip ratio and potentially mitigate the potential adverse health effects associated with an unfavourable distribution of abdominal fat.

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