Online ISSN: 2250-3137
Print ISSN: 2977-0122

ORIGINAL RESEARCH

Relationship Between Anthropometric Measures and Dyslipidemia in Obesity

Dr. Sumit Arora

Assistant Professor, Department of Physiology, N C Medical College & Hospital, Panipat, India

Corresponding Author
Dr. Sumit Arora
Assistant Professor, Department of Physiology, N C Medical College & Hospital, Panipat, India

Received: 13 December, 2020 Accepted: 15 January, 2021

ABSTRACT

Aim: To investigate the association of anthropometric variables with dyslipidemia in obesity and evaluate their effectiveness as predictors of lipid abnormalities. **Materials and Methods:** This cross-sectional study included 150 cardio-metabolically healthy male and female participants. Anthropometric measurements, including waist circumference (WC), waist-to-hip ratio (WHR), and body mass index (BMI), were recorded using standardized protocols. Lipid profiles were analyzed from fasting venous blood samples using standard laboratory methods. Statistical analysis was performed using SPSS version 24.0 to assess the sensitivity, specificity, and predictive values of anthropometric indices for dyslipidemia. **Results:** Obese participants showed significantly higher WC (92.89 ± 6.87 cm), WHR (0.95 ± 0.10), and BMI (28.11 ± 2.5 kg/m²) compared to the non-obese group ($p < 0.001$). Adverse lipid profiles were more prevalent in obese individuals, with higher total cholesterol (241.78 ± 28.07 mg/dL vs. 171.75 ± 23.25 mg/dL), triglycerides (251.88 ± 29.79 mg/dL vs. 106.00 ± 28.49 mg/dL), and LDL levels (134.12 ± 12.02 mg/dL vs. 81.11 ± 9.07 mg/dL), and lower HDL levels (31.79 ± 4.87 mg/dL vs. 44.11 ± 2.88 mg/dL). WC demonstrated the highest sensitivity (68%) for identifying dyslipidemia, while WHR showed the highest specificity (48%) and positive predictive value (92%). However, all parameters had low negative predictive values, highlighting limitations in excluding dyslipidemia in negative cases. **Conclusion:** This study establishes a strong association between obesity, measured through anthropometric indices, and dyslipidemia. WC and WHR emerged as more reliable predictors of dyslipidemia compared to BMI, underscoring their utility in early detection and management of lipid abnormalities. These findings support the use of simple, cost-effective anthropometric measures to identify individuals at risk of cardiovascular diseases and implement timely interventions.

Keywords: Dyslipidemia, obesity, anthropometric indices, waist circumference, lipid profile.

INTRODUCTION

Obesity has been consistently linked to higher rates of dyslipidemia and other cardiovascular risk factors. Body mass index (BMI) is widely regarded as the most practical tool for assessing obesity at a population level. It enables effective comparisons of weight status and adiposity levels within populations, helping to identify at-risk groups. With the global prevalence of obesity rising, this condition has emerged as a significant public health challenge in our country, driven by increasing modernization and the adoption of sedentary lifestyles. Obesity is defined by BMI, calculated as weight in kilograms divided by height in meters squared. According to the WHO, a BMI ≥25.00 is considered overweight, with further classifications as follows: pre-obese (BMI 25.00–29.99), Class I obesity (BMI 30.00–34.99), Class II obesity (BMI 35.00–39.99), and Class III obesity (BMI ≥40.00). [1,2]The Asian cutoff value for overweight and obese is BMI ≥23.0 and ≥25.0, respectively.[3] BMI fails to differentiate weight associated with muscle or fat; so, the fat content varies with body built and proportions across different ethnic populations.[4] Obesity occurs due to complex interaction between faulty dietary habits, sedentary lifestyle, and lack of physical exercise and is aggravated by genetic predisposition in some subsets of population. The WHO states that in 2016, more than 1.9 billion adults (39%) and above were overweight and of these over 650 million (13%) were obese.[5] In India, over the past one decade, men and women who were overweight and obese (BMI ≥25.00 kg/m2) increased from 9.3–18.6% to 12.6–20.7%, respectively.[6] Obesity itself leads to enhanced risk of development of type 2 diabetes (44%), hypertension, 23% of ischemic heart disease, gallbladder disease, 7–41% of some cancers, and degenerative bone diseases.[7] Abdominal fat is very variable for a narrow range of BMI. High waist–hip ratio >1 in men and >0.85 in women indicates abdominal fat accumulation.[8] Recent evidences indicate that detrimental effect on cardiovascular and metabolic health is more correlated by waist circumference (WC).[9,10] Dyslipidemia is common in obesity leading to atherosclerosis. Total cholesterol (TC) to high-density lipoprotein cholesterol (HDL-C) ratio is strongly related to risk of coronary heart disease (CHD).[11] Obese is more likely to have high cholesterol levels, which increases their risk of atherosclerosis. Higher percentage of fat accumulation in truncal area and abdomen is seen in asian Indians which makes them prone for development of insulin resistant syndrome and early atherosclerosis.[12] The National Cholesterol Education Programme Adult Treatment Panel III states that TC < 200 mg/dl is taken as normal and levels more than 240 mg/dl are considered as risk factor for CHD. Furthermore, low-density lipoprotein cholesterol (LDL-C) more than 100 mg/dl and HDL-C <60 mg/dl are considered abnormal.[13]However, due to the inferior cost effectiveness of such modalities compared to time honored anthropometric techniques, the former methods are not practical for routine clinical use. Using simple, noninvasive, anthropometric methods, diagnosing obesity as a possible predictor of dyslipidemia is expected to be helpful in efforts to prevent, diagnose early, and control both mortality and morbidity. Further, identifying the best anthropometric index in any population is essential to predict chronic disease risk factor and to facilitate enhanced screening for disease risk factors. There is lack of representative data regarding the anthropometric profile of south Indians and their association with, dyslipidemia. Hence, the present study intends to compare the ability of simple, non–invasive techniques applicable in field practices in predicting approximately the lipid levels in the body, thus, preventing the future health hazards.

MATERIAL AND METHODS

This cross-sectional study was conducted in the Department of Physiology. After obtaining informed consent, a detailed medical history was collected from each participant. Individuals with a history of dyslipidemia, hypertension, diabetes mellitus, malignancy, or any other major chronic illness; those using lipid-lowering agents or other drug delivery systems; individuals with a family history of lipid-related disorders; as well as critically ill patients presenting with medical emergencies such as myocardial infarction, hyperglycemia, ascites, or pregnancy were excluded from the study.

A total of 150 cardio-metabolically healthy male and female participants were included, selected with the help of a self-structured questionnaire. Waist circumference (WC) was measured in centimeters at the midpoint between the lower costal margin and the iliac crest during the end-expiratory phase using a non-elastic tape. Hip circumference was measured in centimeters at the level of the greater trochanters while the participant stood in a relaxed position. The waist-to-hip ratio (WHR) was calculated as the ratio of WC to hip circumference. Body weight and height were measured without shoes using an electronic measuring scale, and BMI was calculated as weight in kilograms divided by height in meters squared (Quetelet's Index).

For lipid profile analysis, 5 ml of venous blood was collected from each participant after an overnight fast of 12-14 hours. Serum was separated within one hour of collection and stored at -20°C until analyzed. The lipid profile estimations were performed using standard laboratory methods.

Statistical Analysis

All statistical tests were conducted using SPSS version 24.0. Significance value was taken as 'p' < 0.001 or 'p' < 0.05. Sensitivities and specificities of anthropometric indices were compared.

RESULTS

Table 1: Anthropometric Indices and Serum Lipid Profile in Obese and Non-Obese Groups

The comparison of anthropometric indices and lipid profiles between the obese and non-obese groups highlights significant differences. The mean age of participants was slightly higher in the obese group (40.5 ± 8.28 years) compared to the non-obese group (38.5 ± 8.37 years). The mean height was also greater in the obese group (160.7 ± 3.78 cm) compared to the non-obese group (158.1 ± 4.15 cm).Key indicators of adiposity, such as waist circumference (WC), waist-to-hip ratio (WHR), and BMI, were significantly higher in the obese group (p < 0.001). Obese participants had a mean WC of 92.89 ± 6.87 cm, compared to 80.10 ± 7.01 cm in the non-obese group. Similarly, WHR was significantly elevated in the obese group (0.95 ± 0.10 vs. 0.78 ± 0.07), as was BMI (28.11 ± 2.5 kg/m² vs. 23.35 ± 2.7 kg/m²).The lipid profile results further underscore the impact of obesity on dyslipidemia. Obese participants exhibited markedly higher total cholesterol (241.78 ± 28.07 mg/dL vs. 171.75 ± 23.25 mg/dL), triglycerides (251.88 ± 29.79 mg/dL vs. 106.00 ± 28.49 mg/dL), and LDL levels (134.12 ± 12.02 mg/dL vs. 81.11 ± 9.07 mg/dL) compared to the non-obese group (p < 0.001). Conversely, HDL levels were significantly lower in the obese group (31.79 ± 4.87 mg/dL vs. 44.11 ± 2.88 mg/dL). These findings suggest that obesity is strongly associated with adverse lipid profiles, contributing to an elevated risk of cardiovascular diseases.

Table 2: Anthropometric Indices and Lipid Abnormalities

This table categorizes participants based on lipid abnormalities (dyslipidemia) and their anthropometric indices, highlighting differences between obese and non-obese groups. Among the obese participants, waist circumference (WC) identified 29 out of 35 individuals with abnormal lipid profiles, while 6 had normal profiles. Waist-to-hip ratio (WHR) detected abnormal lipid profiles in 22 out of 30 individuals, leaving 8 with normal profiles. Body mass index (BMI) identified 18 out of 27 individuals with dyslipidemia, while 9 had normal lipid profiles. In the non-obese group, WC revealed 11 out of 15 individuals with dyslipidemia, with 4 having normal profiles. WHR showed abnormal lipid profiles in 15 out of 20 participants, while 5 had normal profiles. BMI detected dyslipidemia in 17 out of 23 individuals, with 6 displaying normal profiles. These findings suggest that WC and WHR are slightly better indicators of dyslipidemia in the obese group compared to BMI, as they identified a greater number of individuals with abnormal lipid profiles.

Table 3: Sensitivity and Specificity of Anthropometric Parameters in Predicting Dyslipidemia

The diagnostic performance of waist circumference (WC), waist-to-hip ratio (WHR), and body mass index (BMI) in predicting dyslipidemia was assessed. Among the three anthropometric parameters, WC demonstrated the highest sensitivity (68%), indicating it is the most effective in identifying individuals with dyslipidemia, followed by WHR (62%) and BMI (56%). Regarding specificity, WHR outperformed the other measures, with the highest specificity (48%), indicating its relative accuracy in ruling out individuals without dyslipidemia, followed by WC (44%) and BMI (40%). WHR also had the highest positive predictive value (PPV) at 92%, suggesting that a high WHR is a strong predictor of dyslipidemia, while WC (86%) and BMI (84%) also exhibited strong PPVs. However, all three measures had low negative predictive values (NPVs), with WHR having the lowest NPV (12%), followed by WC and BMI (both at 14%), reflecting their limited ability to reliably rule out dyslipidemia. These findings indicate that WC and WHR are more reliable predictors of dyslipidemia compared to BMI, but all three parameters have limitations, particularly in their ability to exclude dyslipidemia in negative cases.

Table 1: Anthropometric indices and serum lipid profile in obese and non - obese group; values expressed as Mean ±SD

Parameters	Obese group	Non – Obese
Age	40.5 ± 8.28	38.5 ± 8.37
Height	160.7± 3.78	158.1 ± 4.15
Waist circumference (cm)	92.89 ± 6.87	80.10 ± 7.01*
Waist Hip Ratio	0.95 ± 0.10	0.78 ± 0.07*
BMI (kg/ m^2)	28.11 ± 2.5	23.35 ± 2.7*
Total Cholesterol	241.78±28.07	171.75 ± 23.25*
Triglycerides	251.88 ± 29.79	106.00 ± 28.49*
HDL	31.79 ± 4.87	44.11 ± 2.88*
LDL	134.12 ± 12.02	81.11 ± 9.07*

* - p<0.001; obese versus non obese group

Table 2: Anthropometric Indices and serum Lipid Values; n - number of subjects

	Obese			Non – obese		
	N	**Abnormal Lipidprofile**	**Normal Lipid profile**	**n**	**Abnormal Lipidprofile**	**Normal Lipid profile**
WC	35	29	6	15	11	4
WHR	30	22	8	20	15	5
BMI	27	18	9	23	17	6

Table 3: Percent Sensitivity and specificity of anthropometric parameters in predicting dyslipidaemia

	WC (cm)	WHR	BMI (kg/ m^2)
Sensitivity	68	62	56
Specificity	44	48	40
Positive predictive value %	86	92	84
Negative predictive value %	14	12	14

DISCUSSION

Dyslipidemia is a significant, modifiable risk factor for cardiovascular diseases. Its increasing prevalence in recent years can likely be attributed to dietary westernization, economic transitions, and lifestyle changes. Obesity, a major health concern, not only threatens individual well-being but also imposes a considerable burden on healthcare systems. It is strongly linked to endothelial dysfunction, increased arterial stiffness, and insulin resistance. Early identification of obesity using simple and reliable methods can mitigate or reverse these adverse effects. Anthropometric measurements serve as effective surrogate markers of body fat and are strong predictors of dyslipidemia. These methods are advantageous as they are cost-effective, easy to perform, and do not require sophisticated equipment or time-intensive procedures. However, existing literature highlights that the effectiveness of anthropometric indices may vary depending on the study design, geographic location, and characteristics of the population studied.[14-17]

WC, WHR and BMI are good indicators for body fatness and central fat distribution. In our study, anthropometric measures of obesity were significantly correlated with prevalence of dyslipidemia. The association of dyslipidemia with obesity observed in this study is in accordance with previous research reports.[17,18] Further, WC more accurately predicted deranged lipid profile and WHR has rightly projected obese subjects with dyslipidaemia. Studies with computed tomography sections have disclosed the fact of nearer relationship between dyslipidemia and WC.[18-20] An increased WC is most likely associated with elevated risk factors because of its relation with visceral fat accumulation, mechanism may involve excess exposure of the liver to fatty acids.[21]Waist circumference (WC) has been recommended as a better indicator of abnormal fat content in the body than BMI. This has also been validated by the Quebec Health Survey done by Lemeui et al.[22]The inability of BMI to correctly predict deranged lipid profile is in agreement with another broad based study done by Shamai et al.[23]BMI does not take into account proportion of weight related to increased muscle mass, bone weight or visceral organ mass. Individuals with a similar BMI can vary considerably in their abdominal fat mass by virtue of these factors. And hence, with same BMI can have varied range of serum lipid profile. Our study observed that compared with BMI, WC and WHR are good indicators for body fatness in adults at the population level and as well provide additional information about central fat distribution. This is in agreement with the studies of Xu C et al. and the fieldwork done by Feldstein *et al*. in the Chinese and Argentine populations, respectively and thus validates that WC is a better predictor of dyslipidaemia than WHR, WHtR and BMI.[24,25] Identifying early dyslipidaemia can help in instituting corrective measures to reduce disease burden. Raised values of WC and WHR might be useful as relatively inexpensive firststage screening tools to detect dyslipidaemia. Routine health examination will enhance obesity related evaluationof cardiovascular risk factors and thus, in prevention of future health hazards. Present study concluded that WC is a more sensitive and a reliable predictor while WHR is a more specific anthropometric index in predicting dyslipidaemia among healthy individuals. Incorporating these into routine health examination will enhance obesity related evaluation of cardio vascular risk factors and thus, in prevention of future untoward health hazards.

CONCLUSION

This study highlights the strong association between obesity and dyslipidemia, emphasizing the utility of anthropometric indices such as waist circumference (WC), waist-to-hip ratio (WHR), and body mass index (BMI) in predicting lipid abnormalities. Obese participants exhibited significantly higher levels of adverse lipid parameters, including total cholesterol, triglycerides, and LDL, and lower HDL levels compared to non-obese individuals, underscoring the increased cardiovascular risk in obesity. Among the anthropometric parameters, WC demonstrated the highest sensitivity in identifying individuals with dyslipidemia, while WHR showed the highest specificity and positive predictive value, making it a robust predictor of dyslipidemia. However, all three indices had limited negative predictive value, highlighting their challenges in ruling out dyslipidemia. These findings reinforce the importance of using simple, cost-effective anthropometric measures for the early detection of dyslipidemia, enabling timely interventions to reduce cardiovascular risks.

REFERENCE

1. Ashwell M, Gibson S. Waist-to-height ratio as an indicator of 'early health risk': simpler and more predictive than using a 'matrix' based on BMI and waist circumference. *BMJ Open*. 2016;6(3):e010159. doi:10.1136/bmjopen-2015-010159.
2. Kaur S, Sachdev A, Mahajan A, Bhatia AS. Association of anthropometric indices of obesity with hypertension in adolescents. Indian Pediatr. 2018;55(6):555-558.
3. Kumar S, Mahabalaraju DK, Anuroopa MS. Prevalence and risk factors of obesity among medical students in Davanagere city, Karnataka. Indian J Community Med. 2017;42(3):183-187.
4. Huxley R, Mendis S, Zheleznyakov E, Reddy S, Chan J. Body mass index, waist circumference and waist:hip ratio as predictors of cardiovascular risk—a review of the literature. *Eur J Clin Nutr*. 2010;64(1):16-22. doi:10.1038/ejcn.2009.68.
5. Janssen I, Katzmarzyk PT, Ross R. Waist circumference and not body mass index explains obesity-related health risk. *Am J Clin Nutr*. 2004;79(3):379-384. doi:10.1093/ajcn/79.3.379.
6. Klein S, Allison DB, Heymsfield SB, Kelley DE, Leibel RL, Nonas C, Kahn R. Waist circumference and cardiometabolic risk: a consensus statement from shaping America's health: association for weight management and obesity prevention; NAASO, The Obesity Society; the American Society for Nutrition; and the American Diabetes Association. *Obesity (Silver Spring)*. 2007;15(5):1061-1067. doi:10.1038/oby.2007.632.
7. Kuk JL, Ardern CI. Age and sex differences in the clustering of metabolic syndrome factors: association with mortality risk. *Diabetes Care*. 2010;33(11):2457-2461. doi:10.2337/dc10-0942.
8. Lear SA, Humphries KH, Kohli S, Birmingham CL. The use of BMI and waist circumference as surrogates of body fat differs by ethnicity. *Obesity (Silver Spring)*. 2007;15(11):2817-2824. doi:10.1038/oby.2007.334.
9. Matsuzawa Y. The metabolic syndrome and adipocytokines. *FEBS Lett*. 2006;580(12):2917-2921. doi:10.1016/j.febslet.2006.04.028.
10. Okosun IS, Chandra KM, Boev A, Boltri JM, Choi ST, Parish DC, Dever GE. Abdominal adiposity in U.S.

adults: prevalence and trends, 1960-2000. *Prev Med*. 2004;39(1):197-206. doi:10.1016/j.ypmed.2004.01.023.

11. Poirier P, Giles TD, Bray GA, Hong Y, Stern JS, Pi-Sunyer FX, Eckel RH. Obesity and cardiovascular disease: pathophysiology, evaluation, and effect of weight loss: an update of the 1997 American Heart Association Scientific Statement on Obesity and Heart Disease from the Obesity Committee of the Council on Nutrition, Physical Activity, and Metabolism. *Circulation*. 2006;113(6):898-918. doi:10.1161/CIRCULATIONAHA.106.171016.
12. Seidell JC, Perusse L, Despres JP, Bouchard C. Waist and hip circumferences have independent and opposite effects on cardiovascular disease risk factors: the Quebec Family Study. *Am J Clin Nutr*. 2001;74(3):315-321. doi:10.1093/ajcn/74.3.315.
13. Zhu S, Wang Z, Heshka S, Heo M, Faith MS, Heymsfield SB. Waist circumference and obesity-associated risk factors among whites in the third National Health and Nutrition Examination Survey: clinical action thresholds. *Am J Clin Nutr*. 2002;76(4):743-749. doi:10.1093/ajcn/76.4.743.
14. WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet*. 2004;363:157-63.
15. Fred P, Virginie SF, Vincent W, Pascal B. Dyslipidemia and abdominal obesity: an assessment in three general populations. *J Clin Epidemiol*. 2000;53:393-400.
16. Wildman RP, Mackey RH, Bostom A, Thompson T, Sutton-Tyrrell K. Measures of obesity are associated with vascular stiffness in young and older adults. *Hypertension*. 2003;42:468-73.
17. Nguyen NT, Magno CP, Lane KT, Hinojosa MW, Lane JS. Association of hypertension, diabetes, dyslipidemia, and metabolic syndrome with obesity: findings from the National Health and Nutrition Examination Survey, 1999 to 2004. *J Am Coll Surg*. 2008;207:928-34.
18. Deurenberg-Yap M, Chew SK, Deurenberg P. Elevated body fat percentage and cardiovascular risks at low body mass index levels among Singaporean Chinese, Malays, and Indians. *Obes Rev*. 2002;3:209-15.
19. Pouliot MC, Després JP, Lemieux S, Moorjani S, Bouchard C, Tremblay A, et al. Waist circumference and abdominal sagittal diameter: best simple anthropometric indexes of abdominal visceral adipose tissue accumulation and related cardiovascular risk in men and women. *Am J Cardiol*. 1994;73:460-8.
20. Ashwell M, Cole TJ, Dixon AK. Ratio of waist circumference to height is a strong predictor of intra-abdominal fat. *BMJ*. 1996;313:559-60.
21. Seidell JC, Bouchard C. Visceral fat in relation to health: is it a major culprit or simply an innocent bystander? *Int J ObesRelatMetabDisord*. 1997;21:626-31.
22. Lemieux I, Alméras N, Mauriège P, Blanchet C, Dewailly E, Bergeron J, et al. Prevalence of 'hypertriglyceridemic waist' in men who participated in the Quebec Health Survey: association with atherogenic and diabetogenic metabolic risk factors. *Can J Cardiol*. 2002;18(7):725-32.
23. Shamai L, Lurix E, Shen M, Novaro GM, Szomstein S, Rosenthal R. Association of body mass index and lipid profiles: evaluation of a broad spectrum of body mass index patients including the morbidly obese. *Obes Surg*. 2011;21(1):42-7.
24. Xu C, Yang X, Zu S, Han S, Zhang Z, Zhu G. Association between serum lipids, blood pressure, and simple anthropometric measures in an adult Chinese population. *Arch Med Res*. 2008;39:610-7.
25. Feldstein CA, Akopian M, Olivieri AO, Kramer AP, Nasi M, Garrido DA. Comparison of body mass index and waist-to-hip ratio as indicators of hypertension risk in an urban Argentine population: a hospital-based study. *NutrMetab Cardiovasc Dis*. 2005;15:310-5.