**Correlation of Anthropometric Measurements and Cardiovascular Risk Factors Among Medical Students in Ebonyi State University, Nigeria**

**ABSTRACT**

**BACKGROUND**: Anthropometric measurement involves measurement of different parameters which include the height, weight and body mass index. These parameters helped in determining the risk factor associated with cardiovascular diseases. There is highly suspected association between the anthropometric measurements with cardiovascular diseases.

**OBJECTIVES:** This study was designed to assess the relationship between the anthropometric measurement and cardiovascular risk factors.

**METHODOLOGY**: This is a descriptive cross sectional study and a stratified random sampling technique was used, the strata were made up of various levels of study comprising 100-600 levels. A sample size of 294 was gotten. Data was collected using questionnaire. Data was analyzed using IBM SPSS version 23.0 software for descriptive statistics.

**RESULT**: Boys and girls had almost the same mean age 22.13 ± 3.27 and 22.903.47 respectively. The males weighed more than the females with a mean weight of 69.52±11.19. The mean height for the males is 1.72 ± 0.79 were higher than that of the female 1.67 ± 0.069. The systolic and diastolic pressure for the male 119.51 ± 8.23 and 84.31 ± 60.46 respectively were all higher than those of the females 116.77 ± 12.83 and 78.74 ± 9.38 respectively. Males had a mean BMI of 23.15 ± 23.15 while that of the females was 22.73 ± 4.26. Only 1 (0.7%) of the males were obese while none of the female were obese. The females had the higher waist to hip ratio 0.84 ± 0.31 than that of the males 0.8381 ± 0.04. Body mass index (BMI), waist circumference (WC), hip circumference (HC), waist to hip ratio (WHR), waist to height ratio (WHtR) ranges from 0 to 1 with 1 showing a strong association and 0 no association.

**CONCLUSION:** The study came to the conclusion that there was direct significance relationship was seen between anthropometric values and cardiovascular risk factors. The best anthropometric parameters for prediction of cardiovascular risk factors amongst medical students was seen to be BMI which is best suited for use in the screening. Hence the need for attention to be paid to actionable health care policies and plan to keep the risk of cardiovascular complications at bay to the barest minimum.

**KEY WORDS:** Anthropometry, cardiovascular, disease, obesity, Body-Mass-Index.

1. **INTRODUCTION**

**1.1 BACKGROUND OF THE STUDY**

Chronic illnesses represent the primary causes of mortality and long-term disability around the globe. The prevalence of these conditions is rapidly increasing in all parts of the world, affecting people across all economic and social backgrounds. By the year 2020, it was projected that chronic diseases would account for approximately 73% of all global deaths and 60% of the total disease burden. Notably, 79% of these deaths are anticipated to occur in low- and middle-income countries. Among the most significant of these chronic conditions are cardiovascular diseases [1]. Work-related stress is increasingly recognized as a significant risk factor for cardiovascular disease. Additionally, cardiovascular conditions and their associated risk factors—including high blood pressure, diabetes, obesity, physical inactivity, smoking, and elevated blood lipid levels—are among the leading causes of illness and death in many developed nations [2]. In addition, obesity and elevated blood pressure are potential cardiovascular risk factor in every age group [3].There are numerous epidemiological evidences that anthropometric factors are significantly associated with cardiovascular mortality and morbidity [4]. In the recent times, many prospective and cross-sectional studies have been done in order to evaluate the anthropometric measurement methods to assess patients with elevated blood pressure [5]. Different anthropometric measurements like body mass index (BMI) waist circumference (WC) hips circumference (HC) waist to hip ratio (WHR) waist to height ratio are the parameters investigated for this purpose [6]. However, all these anthropometric indicators are good predictors but population and ethnic specific differences have also been found. However, Body Mass Index (BMI) and waist to height ratio are widely used for detecting cardiovascular risks. The biological mechanism for the development of elevated blood pressure is now better understood and is assumed to be associated with multiple reasons. However, genetic factors influence the susceptibility to develop cardiovascular disease [8].

Cardiovascular diseases are one of the major causes of death. It was seen that about 75.5% of men in Limpopo South Africa had comorbidities while hypertension was found to be prevalent in 89% of these cases [17]. Hence, understanding the gravity and types of cardiovascular risk factors among young adults is very significant in establishing targeted intervention before disease progression [7].This area has been relatively understudied and high-quality data from this study is very important. Hence awareness needs to be increased and work needs to be done to improve cardiovascular health. However, the relationship between BMI, Weight to height ratio and Waist Circumference (WC) with elevated blood pressure has not been thoroughly investigated. Therefore, early detection of hypertension and risk factors of blood pressure would be important preventive measure in the population. Hence, this topic is aimed at studying some of the elements associated with this challenge.

The study therefore not only sought to determine the correlation of anthropometric parameters and cardiovascular risk factors among medical students in Ebonyi state university but to further explore the prevalence of cardiovascular risk factors (hypertension) among medical students of Ebonyi State University. In addition to this, authors also set out to investigate the relationship between anthropometric indices with cardiovascular risk factors among medical students. Lastly, the researchers were curious enough to identify the best anthropometric parameters for prediction of cardiovascular risk factors amongst medical students.

**BODY MASS INDEX (BMI)**

Body mass index has been conveniently used to define and classify over weight and obesity. It is an objective scientific measure which uses weight to determine thinness or overweight. It is calculated as weight in kilogram divided by the square of height in meter.

BMI = weight of the body (kg)

Height of the body (m2)

According to WHO classification, the normal range of BMI is from 18.50-24.99 [9]. A BMI value of 25.00-29.99 is classified as grade I overweight, 30 to 39.99 is classified as grade 2 overweight and BMI of 40 and above is classified as grade 3 overweight [10]. Significantly overweight has been linked to a wide range of health problems, especially cardiovascular disorders, diabetes mellitus, and specific forms of cancer. In some regions of Africa, however, obesity continues to be perceived as an indicator of affluence and good health [11][12]. The association between body fat and Body Mass Index (BMI) varies based on age and sex; for instance, women typically have a greater proportion of body fat compared to men at the same BMI level [9]. However, studies between BMI and obesity among older adult show that obesity is a major risk factor for cardiovascular diseases, diabetes mellitus, hypertension and premature death and is increasing in the industrialized countries [13]. As BMI increase the risk of these diseases earlier mentioned may also increase [14].

**WAIST TO HIP RATIO**

Waist-Hip ratio (WHR) is the ratio of the circumference of the waist to that of the hips.

WHR = waist circumference

Hip circumference

Waist-Hip ratio is used to predict BMI, which in turn is a possible indictor for obesity and other more health condition [15].

The World Health Organization (W.H.O) states that the abdominal obesity is defined as waist-Hip ratio above 0.09 for male and 0.85 for female [16].

**METHODOLOGY**

**2.1 STUDY AREA**

The study was conducted in Ebonyi State University, Abakaliki. The University is composed of 9 faculties, namely Basic Medical Sciences (3 departments), Law (5 departments), Clinical Medicine (4 departments), Education (8 departments), Management Science (5 departments), Social Sciences and Humanities (9 departments), Sciences (9 departments), Agriculture and Resource Management Sciences (5 departments), Health Sciences (2 departments). It also boasts of 5 campuses, namely, The Permanent site, Ishieke campus, PRESCO campus, College of Agricultural Science (CAS) campus and Uburu Teaching Hospital, with an estimate population of about 25,000 students.

* 1. **STUDY DESIGN**

This was a cross-sectional descriptive study.

**2.3 STUDY POPULATION**

The study was done amongst medical students of Ebonyi State University.

* + 1. **INCLUSION CRITERIA**

All full-time medical students in the university who gave their consent

* + 1. **EXCLUSION CRITERIA**

Those not available in school during the period of data collection and non-medical students along with visitors tot eh school.

**2.4 SAMPLE SIZE ESTIMATION**.

The total number of medical students in Ebonyi state university is about 900 on estimate. The minimum sample size was determined using Cochran sample size formulae:

Z is the standard normal deviation of 1.96 which correspond to the 95% confidence interval and d is the desired degree of accuracy.

N= 

Where n = the minimum sample size

Z= is the standard normal deviation of 1.96 which correspond to the 95% confidence interval

P=is the prevalence of CVDs risk factors =75.5% (0.7550) [17]

Q= 1-P = 0.245

D=degree of accuracy desired set at 0.05

N= (1.96 )2 \*0.755\*0.50)/ (0.05)2

N = (3.69\*0.755\*0.245)/ 0.0025

N =284.28

Attrition or non-response rate = 10% of sample size

10% of sample size was added to cover for possible non-response during the course of study. Therefore, the estimated sample size is 284.28 + (10% of 284.28) = 284.28 + 28.4=312.423

**2.5 Study Duration**

The study lasted for a period of 8months (January to August 2024).

**2.6 SAMPLING TECHNIQUE**

Stratified and Random Sampling Technique was used. The strata are made up of the various levels of study comprising 100 – 600 levels in the medical school. The total number of medical students in EBSU at these various levels was obtained and added up to get the sample frame. Proportionate allocation of study samples was done to determine the number of students that would be enrolled. The calculation was done using the numbers of students per level as the numerator, the sample frame as the denominator and the estimated sample size as the multiplier.

**2.7 DATA COLLECTION**

There were two different ways used for collecting the data. One was questionnaire based while the other was by physical measurements.

**2.7.1 QUESTIONNAIRE:**

The data was collected using a confidential self-administered semi-structured questionnaire adapted from previous surveys [18]. The questionnaire was used to collect data on knowledge of cardiovascular diseases and also measurements of anthropometric parameters.

**2.7.2 ANTHROPOMETRIC MEASUREMENTS**

**1. BLOOD PRESSURE MEASUREMENT**:

Every subject’s BP was measured with a standardized protocol. The subjects rested for at least 10 minutes in seated position and their arms supported at the level of heart in optimal room conditions. At least two blood measurements at a five minutes interval were taken

**2. HEIGHT MEASUREMENT**

Every subject’s height was measured in meters (m) while the participant stood still without shoes.

**3. WEIGHT MEASUREMENT**

The weight of each of the subjects was measured in kilogram (kg) with electronic weighing scale.

**4. CALCULATION OF BODY MASS INDEX**

BMI was calculated as weight divided by square of height in metres (kg/m2).

**5. WAIST AND HIP MEASUREMENT**

The waist circumference (WC) was measured in centimeters at the midpoint between the bottom of the ribs and the top of the iliac crest. Hip circumference was measured at the largest posterior extension of the buttocks.

**6. CALCULATION OF WAIST TO HIP RATIO**

Waist to hip ratio (WHR) was calculated by dividing the values of waist measurement with that of hip measurement.

**2.8 PRETESTING**

To ensure the reliability, the instrument of study was pre tested with 300 level physical science students of college of medicine, Ambrose Alli University Ekpoma Edo state who fit into the inclusion criteria. The first draft of questionnaires was based on the literature review on the specific objectives. The questionnaire was administered to 10% of sample size of 312 which was 31 participants. The data was collected and analyzed using the SPSS software and was used to design the standardized structured questionnaire.

**2.9 DATA MANAGEMENT/STATISTICAL ANALYSIS**

The data collected was entered in Statistical Package for Social Scientist (SPSS) software version 22 [19], which was also be used for the analysis. Descriptive and inferential statistics were done with the aid of the SPSS software. The results were displayed on table and charts. T-test was used to determine association between dependent and independent variables. Binary logistic regression was used to ascertain the predictors of cardiovascular risk factors.

**3.0 RESULTS and Discussion:**

Three hundred (312) copies of the questionnaire were administered. All were returned, but two hundred and ninty four (294) were completely filled and fit for analysis giving a 94.23% response rate.

**Table 1: Socio-demographic Factors**

|  |  |  |
| --- | --- | --- |
| **Variable** | **Frequency (n = 294)** | **Percentage** |
| **Mean** |  |  |
| **Age group** |  |  |
| 16 – 20 | 99 | 33.7 |
| 21 – 24 | 99 | 33.7 |
| 25 – 28 | 87 | 29.6 |
| 28 - 32 | 8 | 2.7 |
| 33 and above  **Mean (SD) = 22.55 (3.4)** | 1 | .3 |
| **Sex** |  |  |
| Female | 159 | 54.1 |
| Male | 135 | 45.9 |
| **Religion** |  |  |
| Christianity | 284 | 96.6 |
| Islam | 7 | 2.4 |
| Traditional religion | 3 | 1.0 |
| **Marital Status** |  |  |
| Single | 272 | 92.5 |
| Married | 19 | 6.5 |
| Separated | 2 | 0.7 |
| widowed | 1 | 0.3 |
| **Ethnic Group** |  |  |
| Igbo | 253 | 86.1 |
| Yoruba | 28 | 9.5 |
| Hausa | 9 | 3.1 |
| Ijaw | 4 | 1.4 |
| **Educational Level** |  |  |
| 100 | 49 | 16.7 |
| 200 | 52 | 17.7 |
| 300 | 54 | 18.4 |
| 400 | 50 | 17.0 |
| 500 | 50 | 17.0 |
| 600 | 39 | 13.3 |

Table 1 above shows the socio-demographic factors of the respondents.

**Table 2: Prevalence of cardiovascular risk factors for disease**

|  |  |  |
| --- | --- | --- |
| **Variables** | **Frequency (n = 294)** | **Percentage** |
| **Hypertension** |  |  |
| No | 285 | 96.9 |
| Yes | 9 | 3.1 |
| **Obesity** |  |  |
| No | 224 | 76.2 |
| Yes | 70 | 23.8 |
| **Do you smoke** |  |  |
| No | 246 | 83.7 |
| Yes | 48 | 16.3 |
| **Do you drink alcohol** |  |  |
| No | 167 | 56.8 |
| Yes | 127 | 43.2 |
| **Do you exercise at least 30 minutes weekly?** |  |  |
| No | 105 | 35.7 |
| Yes | 189 | 64.3 |
| **Any family history of cardiovascular disease?** |  |  |
| No | 179 | 60.9 |
| Yes | 115 | 39.1 |
| **Are you on any medication for a chronic disease?** |  |  |
| No | 257 | 87.4 |
| Yes | 37 | 12.6 |
| **Do you eat a lot of junk diet (indomie, gala, coke, chin chin)** |  |  |
| No | 91 | 31.0 |
| Yes | 203 | 69.0 |
| **Total Prevalence** |  | **33.93** |

**Table 3: Relationship between BMI, Hip circumference, Waist Circumference, Waist to hip ratio and waist to height ratio factors for cardiovascular disease**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variables** | **BMI** | **WC** | **HP** | **WHR** | **WHtR** |
| **Hypertension** |  |  |  |  |  |
| ԏ | 0.953 | 0.482 | 0.472 | 0.488 | 0.370 |
|  |  |  |  |  |  |
| **Obesity** |  |  |  |  |  |
| ԏ | 1.000 | 0.612 | 0.623 | 0.491 | 0.524 |
|  |  |  |  |  |  |
| **Do you smoke?** |  |  |  |  |  |
| ԏ | 0.892 | 0.345 | 0.401 | 0.331 | 0.299 |
|  |  |  |  |  |  |
| **Do you drink alcohol?** |  |  |  |  |  |
| ԏ | 0.855 | 0.346 | 0.498 | 0.360 | 0.300 |
|  |  |  |  |  |  |
| **Do you exercise at least 30 minutes weekly?** |  |  |  |  |  |
| ԏ | 300 | 0.451 | 0.425 | 0.410 | 0.274 |
|  |  |  |  |  |  |
| **Any family history of cardiovascular disease?** |  |  |  |  |  |
| ԏ | 0.901 | 0.313 | 0.398 | 0.320 | 0.226 |
|  |  |  |  |  |  |
| **Do you eat a lot of junk diet (Indomie, gala, coke, chin chin)?** |  |  |  |  |  |
| ԏ | 0.864 | 0.381 | 0.401 | 0.367 | 0.307 |

BMI = Body mass index, WC = Waist circumference, HP = Hip circumference, WHR = Waist to hip ratio, WHtR = Waist to height ratio.

Table above shows BMI having the highest association between cardiovascular risk factor and anthropometric parametric. BMI had a perfect association of 1 with obesity. The anthropometric parameter with the least association is waist to height ratio (WHtR).

Therefore, we can conclude that best anthropometric parameter to predict cardiovascular risk factors is body mass index (BMI).

**Table 4: Characterization and Distribution of Anthropometric Indices**

|  |  |  |
| --- | --- | --- |
| **Indicators** | **Males (n = 135) n (%)** | **Females (n = 159) n (%)** |
| **Age** (Years) | 22.13 ± 3.27 | 22.90 ± 3.47 |
|  |  |  |
| **Weight** (kg) | 69.52 ± 11.19 | 63.83 ± 9.78 |
|  |  |  |
| **Height** (M) | 1.72 ± .079 | 1.67 ± 0.069 |
|  |  |  |
| **Systolic blood pressure** | 119.51 ± 8.23 | 116.77 ± 12.83 |
|  |  |  |
| **Diastolic blood pressure** | 84.31 ± 60.46 | 78.74 ± 9.38 |
|  |  |  |
| **Waist circumference**(cm) | 80.26 ± 6.81 | 76.37 ± 9.83 |
|  |  |  |
| **Hip circumference** | 95.83 ± 13.77 | 93.57 ± 14.51 |
|  |  |  |
| **BMI** (kg/m2) | 23.15 ± 23.15 | 22.73 ± 4.26 |
|  |  |  |
| **Low weight** | 2 (1.5) | 14 (8.8) |
| **Low weight risk** | 98 (72.6) | 106 (66.7) |
| **Eutrophic** | 28 (20.7) | 29 (18.2) |
| **Overweight** | 6 (4.4) | 10 (6.3) |
| **Obesity** | 1 (0.7) | 0 |
| **Waist to hip ratio** | 0.8381 ± 0.04 | 0.84 ± .031 |
| **Waist to height ratio** | 0.46 ± 0.04 | 0.46 ± 0.06 |

This study was undertaken to evaluate the prevalence of cardiovascular risk factors among medical students in Ebonyi State University. It was seen that the mean age was 22.55years with a S.D of ±3.400. Majority were However, similar studies carried in Enugu, South Eastern Nigeria [20] and in Angola [21] reported a higher mean age of the 59.8yrs (S.D. ±9.9) and 44.5(S.D. ± 10.6) respectively. This is because these study studies focused on middle aged and elderly population.

Females were the majority (54.1%) who participated in this study. In studies conducted in Enugu Eastern Nigerian [20], Ladoke Akintola University of Technology, Ogbomoso, Oyo[22], Western Nigeria and Angola [21] the percentage of females was found to be 71.2%, 53.4%, and 52% respectively. This is majorly due to the fact that there were more female participants in the area of study.

All most all of the respondents 92.5% were single, 6.5% were married, 0.7% separated and 0.3% widowed. A contrast was found in a study in Oyo, Western Nigeria [23] where 97.1% were married. This is expected as then age distributions were mostly young adults. It is not a common culture to have married young adults in this part of the world. Also, university degree seems to be one of the factor men consider before get married. Hence, only few get married during their undergraduate studies.

Earlier studies conducted in Ladoke Akintola University of Technology, Ogbomoso, Nigeria [22] showed high prevalence of Hypertension 84 (40.8%), visceral obesity 92 (44.7%), and generalized obesity 79 (38.3%). Another study in Tunisia [24] showed a similar result with high prevalence of hypertension of 18.8% with an adjusted rate of 15.%, history of diabetes of 10.2%, and obesity (body mass index >30) of 27.7%, smoking habits 21.5%. This study showed a contrasting result for hypertension with low prevalence of 3.1%. This finding may be associated with the fact that parent or guardian takes care of virtually everything the students need to care for themselves. Their only worry is how to study and get good grades. However, the 3.1% who have hypertension maybe the unlucky ones who carter for their need, pay their fees and probably have other sibling depending on them. Prevalence for alcohol was 43.2%, family history of cardiovascular diseases 64.3%, and junk diet 12.6%. Time constraint is one for the reasons for poor diet among students. In addition to lack time, many students do not have access to kitchen. This leads students to cut corners and make do with junk diet. Some students shy away from cooking and visiting the grocery store as time not just to prepare, but to sort out what is unhealthy versus what is not. For smoking, the prevalence was 16.3% which is similar to a study done in Angola [21] with a prevalence of 10.2%. This could be because smoking is not a well cultural accepted habit in this part of the world. Prevalence for exercise at least 30 minutes daily was 43.2%. This is due to the increased use of computers and the greater occupation of time by students in activities related to the university interferes negatively in the practice of physical activities. This is similar to the result obtained from Angola[21] 83% and Brazil [25] (5) 30%.Obesity is an excess of body fat, and it has become a worldwide epidemic, not only in Nigeria but also in other parts of the world. In total, 23.8% of medical students in Ebonyi State University who took part in this survey were overweight. Overall, the total prevalence of cardiovascular risk factors among medical students in Ebonyi State University was 33.98%. Urbanization is expected to increase the level of these cardiovascular risk factors as a result of the adoption of new dietary habits, sedentariness and the stress of working conditions in an urban area.

Anthropometric indicators associated with cardiovascular risk factors were used during our study. This includes, body mass index (BMI), hip circumference, waist circumference, waist to hip ratio and waist to height ratio.

Our study shows that body mass index (BMI) was the best performing anthropometric parameter in terms of predicting cardiovascular risk factors. This is in contract with studies done in Brazil [25] and China [26] which showed the waist to height ratio (WHtR) as the best performing in predicting the cardiovascular risk factors. The BMI showed a perfect association with obesity. This was expected as the BMI was used to determine the obesity.

This also observed that male medical students have a higher systolic and diastolic blood pressure when compared to the female medical students. This could be as a result of excessive alcohol consumption among the males. There are not many studies about the association between alcohol consumption and anthropometric variables, making it difficult to compare the results of this study. Consumption of alcohol whether excessive or not, seems to be associated with adiposity and abdominal obesity in young adults [25]. The males also had a higher body weight and height. However, 6.3% females were more obese compared to the 4.4% of the males who were overweight. It could be because women generally have higher percentage of body fat. Women require fewer calories per pound of body weight daily than men do.

**5. CONCLUSION**

The prevalence of cardiovascular risk factors among the medical students was high. BMI was seen to be having the highest association between cardiovascular risk factor and anthropometric. BMI had a perfect association of 1 with obesity; the anthropometry with least association is waist to height ratio (WHtR).

Therefore, we conclude that the best anthropometric parameter to predict cardiovascular risk factors is body mass index (BMI). BMI is best suited for use in the screening of cardiovascular risk factors.

**RECOMMENDATION**

1. **The health sectors:** There is growing common opinion that BMI should be considered as a vital sign and recorded in the same manner as weight and height in the medical chart of every patient. Some investigators claimed that waist could replace both BMI and WHR as a simple indicator of management as health promotion activity. Measurement of BMI alone can be a proxy of abdominal fat mass. Our result supports that BMI should remain a part of screening following measurements in patient with elevated blood pressure as such it is therefore recommended that BMI measurement should be a simple clinical measurement for the dictating adult with possible health risks due to cardiovascular disease. Hence, researchers suggest that the approach to reduce the risk of cardiovascular disease is to prevent over weight.

**2. The government:** Policies should be made by the government to ensure programs that would help in weight loss for the population are implemented. Furthermore, regular health checks should be ensured by all government and private establishments in order to ensure that citizens healthcare are prioritized.

**3. The populace:** People should make effort to be enlightened on the need to follow up on routine medical checkups. Deliberate efforts should be made on the need to exercise and participating in healthy body practices that would contribute to healthy living.

**ETHICAL APPROVAL:**

Ethical clearance for this study was obtained from Research and Ethics Committee of Ebonyi State University, Abakaliki.

**Consent:**

Written consent was obtained from the respondents (male female medical students) after full explanation of the study purpose and their rights as participants are provided by the researchers. Data was then be collected and confidentiality was maintained by non- inclusion of self- identifying characteristics in the questionnaire.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

Authors hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts. This guarantees the fact that the originality of the study was maintained.

**COMPETING INTERESTS DISCLAIMER:**

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

**REFERENCES**

1. Schmidt H. Chronic Disease Prevention and Health Promotion. 2016 Apr 13. In: H. Barrett D, W. Ortmann L, Dawson A, et al., editors. Public Health Ethics: Cases Spanning the Globe [Internet]. Cham (CH): Springer; 2016. Chapter 5. Available from: https://www.ncbi.nlm.nih.gov/books/NBK435779/ doi: 10.1007/978-3-319-23847-0\_5
2. Kivimäki M, Kawachi I. Work Stress as a Risk Factor for Cardiovascular Disease. Curr Cardiol Rep. 2015;17(9):630. doi:10.1007/s11886-015-0630-8
3. Jeong, S.I., Kim, S.H. Obesity and hypertension in children and adolescents. *Clin Hypertens* **30**, 23 (2024). <https://doi.org/10.1186/s40885-024-00278-5>
4. Hassan, S., Oladele, C., Galusha, D. et al. Anthropometric measures of obesity and associated cardiovascular disease risk in the Eastern Caribbean Health Outcomes Research Network (ECHORN) Cohort Study. BMC Public Health 21, 399 (2021). <https://doi.org/10.1186/s12889-021-10399-3>
5. Canyolu BA, Şen N, Sadıç BÖ. Anthropometric indexes for predicting high blood pressure in Turkish adults. *J Family Med Prim Care*. 2023;12(11):2848-2854. doi:10.4103/jfmpc.jfmpc\_460\_23
6. Nkeh-Chungag BN, Mxhosa TH, Mgoduka PN. Association of waist and hip circumferences with the presence of hypertension and pre-hypertension in young South African adults. Afr Health Sci. 2015;15(3):908-916. doi:10.4314/ahs.v15i3.27
7. Gooding HC, Gidding SS, Moran AE, et al. Challenges and Opportunities for the Prevention and Treatment of Cardiovascular Disease Among Young Adults: Report From a National Heart, Lung, and Blood Institute Working Group. *J Am Heart Assoc*. 2020;9(19):e016115. doi:10.1161/JAHA.120.016115
8. Amirabdollahian F, Haghighatdoost F. Anthropometric Indicators of Adiposity Related to Body Weight and Body Shape as Cardiometabolic Risk Predictors in British Young Adults: Superiority of Waist-to-Height Ratio. *J Obes*. 2018;2018:8370304. Published 2018 Nov 1. doi:10.1155/2018/8370304.
9. Weir CB, Jan A. BMI Classification Percentile And Cut Off Points. [Updated 2023 Jun 26]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK541070/>
10. World Health Organization News (WHO) room. Obesity. <https://www.who.int/health-topics/obesity>. 2025
11. Bhupathiraju SN, Hu FB. Epidemiology of Obesity and Diabetes and Their Cardiovascular Complications. Circ Res. 2016;118(11):1723-1735. doi:10.1161/CIRCRESAHA.115.306825
12. Owobi, O.U.; Okonji, O.C.; Nzoputam, C.I.; Ekholuenetale, M. Country-Level Variations in Overweight and Obesity among Reproductive-Aged Women in Sub-Saharan Countries. Women 2022, 2, 313-325. <https://doi.org/10.3390/women2040029>
13. Lin, H., Xiao, N., Lin, S., Liu, M., & Liu, G. G. (2024). Associations of hypertension, diabetes and heart disease risk with body mass index in older Chinese adults: a population-based cohort study. *BMJ open*, *14*(7), e083443. <https://doi.org/10.1136/bmjopen-2023-083443>
14. World Health Organization News (WHO) room. Waist Circumference and Waist–Hip Ratio: Report of a WHO Expert Consultation (2025) <https://iris.who.int/bitstream/handle/10665/44583/9789241501491_eng.pdf>
15. World Health Organization News (WHO) room. Obesity and Overweight. (2025). <https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight>
16. Russo C, Sera F, Jin Z, et al. Abdominal adiposity, general obesity, and subclinical systolic dysfunction in the elderly: A population-based cohort study. *Eur J Heart Fail*. 2016;18(5):537-544. doi:10.1002/ejhf.521
17. Mphasha MH, Skaal L, Mothiba TM. Prevalence of overweight and obesity amongst patients with diabetes and their non-diabetic family members in Senwabarwana, Limpopo province, South Africa. *S Afr Fam Pract (2004)*. 2022;64(1):e1-e7. Published 2022 May 25. doi:10.4102/safp.v64i1.5409
18. Tony, L., Areekal, B., Surendran Nair, A. T., Ramachandran, R., Philip, R. R., Rajasi, R. S., & K., V. (2016). Prevalence of hypertension and pre-hypertension among adolescent school children in Thiruvananthapuram, Kerala, India. International Journal Of Community Medicine And Public Health, 3(12), 3556–3563. <https://doi.org/10.18203/2394-6040.ijcmph20164291>
19. IBM Corp.Released 2013.IBM SPSS Statistics for windows, Version 22.0.Armonk,NY: IBM Corp.
20. Chukwuemeka O. Eze, Uma A. K, Thomas N." 2020Cardiovascular Risk Factors in South-Eastern Nigeria: A Community Based Survey" published by World Journal of Cardiovascular Diseases Vol.10 No.7.
21. Pedro JM, Brito M, Barros H. Cardiovascular Risk Assessment in Angolan Adults: A Descriptive Analysis from CardioBengo, a Community-Based Survey. Int J Hypertens. 2018;2018:2532345. Published 2018 Sep 6. doi:10.1155/2018/2532345
22. Babatunde, O. A., Olarewaju, S. O., Adeomi, A. A., Akande, J. O., Bashorun, A., Umeokonkwo, C. D., & Bamidele, J. O. (2020). 10-year risk for cardiovascular diseases using WHO prediction chart: findings from the civil servants in South-western Nigeria. *BMC cardiovascular disorders*, *20*(1), 154. <https://doi.org/10.1186/s12872-020-01438-9>
23. Awosoga OA, Oyewole OO, Adegoke OM, et al. Cardiovascular disease risk perception among community-dwelling adults in southwest Nigeria: A mixed-method study. PLoS One. 2024;19(11):e0313578. Published 2024 Nov 12. doi:10.1371/journal.pone.0313578
24. Ben Ayed, H., Ben Jemaa, M., Trigui, M., Ben Hmida, M., Kassis, M., Jedidi, J., Karray, R., Abid, L., Sourour, Y., & Damak, J. (2019). Cardiovascular diseases in Southern Tunisia: current trends and future projections. La Tunisie medicale, 97(5), 659–666.
25. Brant LCC, Nascimento BR, Veloso GA, et al. Burden of Cardiovascular diseases attributable to risk factors in Brazil: data from the "Global Burden of Disease 2019" study. Rev Soc Bras Med Trop. 2022;55(suppl 1):e0263. Published 2022 Jan 28. doi:10.1590/0037-8682-0263-2021
26. Xiang H, Yang R, Tu J, Guan X, Tao X. Health Impacts of High BMI in China: Terrible Present and Future. Int J Environ Res Public Health. 2022;19(23):16173. Published 2022 Dec 2. doi:10.3390/ijerph192316173