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Abdominal And Gluteofemoral Fat Distribution As Risk Factor Among The Plains Garo Women Of Kamrup District, Assam

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KEYWORDS

Garo women, fat distribution, abdominal and gluteofemoral region, physical activity

ABSTRACT

The Garo women perform vigorous physical activity which is expected to bring changes in their body build and in the complications arising due to metabolic syndrome. The present work is an attempt to assess the disease risk of the Garo women from anthropometric measures of abdominal and gluteofemoral areas taking into account age, education and physical activity of the subjects as covariates. Considering both waist and hip circumference simultaneously identifies almost 20% more people as being at higher risk of death compared with using waist circumference alone. The majority of the women of the present study claimed to be physically fit when asked to self-report their health status. No cases of heart-related ailments were reported from them which might have arisen due to fat deposition in the abdominal and gluteofemoral area. This proposes that improvement of physical activity in an obese patient may improve their health regardless of whether the patient stays fat.

Introduction

Body fat distribution is a major determinant of metabolic health and cardiovascular risk factor. Population studies show that an increased gluteofemoral fat mass is independently associated with a protective lipid and glucose profile, as well as a decrease in cardiovascular and metabolic risk (Manolopoulos *et al*. 2010). Since it is an important risk factor, the proportion of abdominal to gluteofemoral body fat, as measured, for example, by the waist-to-hip ratio, correlates with obesity-associated diseases and mortality and is a stronger cardiovascular risk marker than BMI (Canoy *et al*. 2004; Grundy *et al*. 2008; Yusuf *et al*. 2005).

Risk factors are traits, conditions, or habits that increase chance of developing a disease. The five conditions described below are metabolic risk factors. Any one of these risk factors may occur by itself, but they tend to occur together. At least three metabolic risk factors are required to be diagnosed with metabolic syndrome. (Metabolic Syndrome, 2019)

A large waistline. This also is called abdominal obesity or “having an apple shape.” Excess fat in the stomach area is a greater risk factor for heart disease than excess fat in other parts of the body, such as on the hips.

A high triglyceride level. Triglycerides are a type of fat found in the blood.

A low HDL cholesterol level. HDL sometimes is called “good” cholesterol. This is because it helps remove cholesterol from your arteries. A low HDL cholesterol level raises your risk for heart disease.

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High blood pressure. Blood pressure is the force of blood pushing against the walls of your arteries as your heart pumps blood. If this pressure rises and stays high over time, it can damage your heart and lead to plaque build-up.

High fasting blood sugar. Mildly high blood sugar may be an early sign of diabetes.

So, an increase in fat mass is considered to be an important risk factor for the worldwide increase in Type 2 diabetes and cardiovascular disease. However, for a given fat mass, there is a large variability in the risk prediction of these cardio metabolic diseases. For example, some lean people unexpectedly have a risk of Type 2 diabetes and cardiovascular disease that is similar to the increased risk that is observed in most people who have obesity. What both of these phenotypes have in common is a very characteristic fat distribution. As a result, much focus has been given on the strong predictive power of increased visceral fat mass (Stefan 2020).

Considering both waist and hip circumference simultaneously identifies almost 20% more people as being at higher risk of death compared with using waist circumference alone, and is a simple and cost-effective way of identifying body shapes associated with increased risk of premature death. Waist circumference (WC) and hip circumference (HC) are commonly used and easily understood measures of abdominal (upper-body) and gluteofemoral (lower-body) body size, respectively. WC is primarily a measure of visceral/ectopic and subcutaneous adipose tissue around the waist, whereas HC measures both adipose tissue and lower-body muscle mass (Cameron *et al.* 2020). Numerous studies have shown that larger WC is strongly related to morbidity and premature death, while there is some evidence that larger HC is protective for these same outcomes (Snijder *et al.* 2004; Beigaard *et al.* 2004; Heitmann and Frederiksen 2009; Neeland *et al.* 2018; Manolopoulos *et al.* 2010).

A more complex relationship between hip circumference, waist circumference, and risk of death was found by Cameron *et al.* (2020) which were revealed when both measures are considered simultaneously. This is particularly true for individuals with smaller waists, where having larger hips was protective. Considering both waist and hip circumference in the clinical setting could help to best identify those at increased risk of death.

WHO projections show that Non Communicable Diseases (NCDs) will be responsible for a significantly increased total number of deaths in the next decade. NCD deaths are projected to increase by 15% globally between 2010 and 2020 (to 44 million deaths). The greatest increases will be in the WHO regions of Africa, South-East Asia and the Eastern Mediterranean, where they will increase by over 20%. In low- and middle-income countries, 29% of NCD deaths occur among people under the age of 60, compared to 13% in high-income countries. Most NCDs are strongly associated and causally linked with four behaviours: tobacco use, physical inactivity, unhealthy diet and the harmful use of alcohol.

People who are insufficiently physically active have a 20–30% increased risk of all-cause mortality compared to those who engage in at least 30 minutes of moderate intensity physical activity on most days of the week (WHO 2010). Physical activity is considered as a complex, multi-dimensional behaviour. Many different modes of activity contribute to total physical activity, and this includes occupational, household (e.g. caregiving, domestic cleaning), transport (e.g. walking or cycling to work) and leisure-time activities (e.g. dancing, swimming). Physical activity can be further categorised in terms of the frequency, duration and intensity of the activity.

The women of the Garo community are hard workers. Apart from working at home, working in the orchards or collecting firewood from the nearby hills is a major part of their daily activities. This vigorous physical activity that they perform is expected to bring changes in their body build and in the complications arising due to metabolic syndrome. Keeping this in mind, this paper is an attempt to assess the disease risk of the Garo women from anthropometric measures of abdominal and gluteofemoral areas taking into account age, education and physical activity of the subjects as covariates.

Materials and methods

The Garos are a Tibeto-Burman ethnic group in Meghalaya, Assam, Tripura, Nagaland and neighbouring areas of Bangladesh like Mymensingh, Netrokona, Jamalpur, Sherpur and Sylhet, who call themselves A·chik Mande (literally "hill people", from *a·chik* "bite soil"+ *mande* "people") or simply A·chik or Mande. The Garos are one of the Scheduled tribes in the North-Eastern state of Meghalaya, India. The Garos are mainly distributed over the Garo Hills in Meghalaya, Kamrup, Goalpara, KarbiAnglong districts of Assam, Khasi Hills in Meghalaya and Dimapur (Nagaland State), substsntial numbers (about 200,000) are found in greater Mymensingh (Tangail, Jamalpur, Sherpore, Netrakona, Mymensingh) and capital Dhaka, Gazipur, Sirajgonj, Rangpur, Sunamganj, Sylhet, Moulovibazar districts of Bangladesh. It is estimated that total Garo population in Meghalaya, Assam, Nagaland, Tripura, West Bengal, Canada, USA, Europe, Australia and Bangladesh together is more than 1 million. (Lewis *et al.* 2013). According to the census of India, 2011 there are 26000 Garos in Kamrup (Rural).

The present cross-sectional study was undertaken among the plains Garo women of villages under Boko and Chaygaon development block. These villages are about 70-75 km away from Guwahati city which falls under Kamrup district of Assam. The name of the villages in descending order of their distances from Guwahati city are Kompaduli, Gohalkona, Rajapara, Nongldonga, Amrengkona, Kinangaon, Santipur, Hanthaikona, Koroibari, Jangrapitha.

The study was carried out among 862 adult Plains Garo females from 18 - 80 years of age. Data was collected from women who voluntarily agreed to participate in the study. Age of the women has been collected after verifying the written record. Those women who did not have a birth record, their age were estimated by referring to some important local events. Pregnant and sick women were not included in the study.

Age grouping: The women have been classified as per their age groups. The age groups have been divided into 5 year intervals. For the ease of classification, the women below 20 years have been made into a separate group, the women from the age 20 to 59 years have been divided into 8 groups with 5 year intervals and the women of age 60 years and above have been grouped in a separate age group as they belong to the elderly category.

Educational status: The educational groups has been divided as follows: illiterate – no formal education, pre - primary – class nursery to kindergarten, primary – class 1 to 5, middle school – class 6 to 8, secondary school – class 9 and 10, senior secondary school – class 11 and 12, graduation and post-graduation (Indian standard classification of education, 2014).

Physical activity: data on physical activity was collected using the Global Physical Activity Questionnaire (GPAQ) developed by World Health Organisation (2002) to assess the physical activity performed by the person in one week. It collects information regarding physical activities performed in three domains, i.e., (i) activities at work, (ii) activities performed while travelling, (iii) recreational activities. GPAQ consists of total sixteen questions. It covers several components of physical activity, such as intensity, duration, and frequency. Data is taken for moderate and vigorous intensity activities. A person is said to be having a sedentary lifestyle if the total activities performed by a person in a week are less than any of the following.

150 minutes of moderate intensity physical activity OR

75 minutes of vigorous-intensity activity OR

An equivalent combination of moderate and vigorous-intensity physical activity achieving at least 600 MET-minutes.

Both vigorous and moderate intensity activities were recorded if it is done for at least 10 minutes continuously. Vigorous – intensity activities are activities that require hard physical effort and cause large increases in breathing or heart rate. Moderate – intensity activities are activities that require moderate physical effort and cause small increases in breathing or heart rate like brisk walking or carrying light loads. Moderate activities during travel include walking or using bicycle. (WHO 2002)

Anthropometric measures taken into consideration of abdominal and gluteofemoral region in the study

Waist Circumference (WC) – WC was measured at the minimum circumference between the last rib and the iliac crest. WHO experts addressed the recommended cut-off points for waist circumference of women as follows: >80 cm – increased risk of metabolic complications and >88 cm – substantially increased risk of metabolic complications (WHO 2008).

Hip Circumference (HC) – Hip circumference was measured at the maximum protuberance of the buttocks. The derived indices of waist circumference and hip circumference considered for the present study are waist to height ratio (WHtR), conicity index (CI), waist to hip ratio (WHR).

Waist – Height Ratio (WHtR) – This is the ratio (R) of the waist circumference – (WC-) to height (Ht). The WHtRcutoff value of ≥0.5 is efficient and supported that increased adiposity was substantially related to the risk of Cardio vascular disease. (Son 2016 and Ashwell 2005).

Conicity Index (CI) – The conicity index is used to assess the central adiposity by assuming the body as a perfect cylinder, i.e. the deviation from a cylindrical shape is due to central adiposity. The index is obtained using the formula, $CI = WC(m) / [0.109 \times \sqrt{weight(kg)/height(m)}]$ (Valdez *et. al.*, 1993). For cardiovascular risk calculation, the values proposed for women is ≥1.18 and for men is ≥1.25 (Pitanga *et. al.*, 2005).

Waist – Hip Ratio (WHR) – This is the ratio of waist circumference to hip circumference. WHO experts addressed the recommended cut-off point for waist – hip ratio of women as 0.85 cm. WHR greater than or equal to 0.85 means a substantially increased risk of metabolic complication (WHO 2008).

Analysis of data: All descriptive data pertaining to anthropometric measures has been reported as mean and standard deviation. The data were analysed using the Statistical Package for Social Sciences (SPSS) version 17.0. For group comparisons one-way ANOVA was applied. Pearson's correlation (two tailed) was used to evaluate the strength and direction of linear relationship between variables. Linear regression was used to explain the variation of dependent variable by the independent variable. The p-values of <0.05 and <0.01 were considered to be statistically significant.

Results

The descriptive statistics of the anthropometric measurements, their ratios and indices according to their age, educational level and physical activity status of the Garo women are presented in Table 1. With the increase of age, the mean WC, HC and WHtR increases. This increase continues up to the age of 50 – 54 years and then it slightly decreases. In case of CI and WHR the value increases steadily up to the last age group i.e. 60 years and above. With respect to educational qualification, the mean WC, HC, WHtR and CI decreases as educational level increases. Only in case of WHR the mean is .87 among the illiterates and there after it decreases to .86 and remains same for the next group i.e. senior secondary/graduate and post graduate level. When the different variables are seen against physical activity, the mean WC, HC, WHtR is more among the women who did vigorous activity than among the women who did moderate activity, whereas the value of CI and WHR shows a lesser value among the women doing vigorous activity.

The relationship between WC, WHtR, CI and WHR with age groups is analysed in Table 3. Noticeably higher proportions of women are found to be normal or with no risk of disease in the age group ≤19 years as per WC (93.3%), WHtR (73.3%), CI (58.3%) and WHR (56.7%). With the increase of age, the percentage of women without risk decreases as detected by all these indices. Higher proportion of women are found to be in the disease risk category in the age group 60≤ years as per WC (56.3%), WHtR (76.5%), CI (87.7%), WHR (70.4%). The percentage of women with normal indices decreases to 44.4% for WC, 23.8% for WHtR, 12.3% for CI and 29.6% for WHR.

Anthropometric measures as the predictors of disease risk according to educational level has been analysed in Table 4. Noticeably higher proportions of women are found to be normal or with no risk of disease in the senior secondary/graduate/post graduate group as per WC (66.3%), WHtR (56.3%), CI (45.0%) and WHR (47.5%). Higher proportion of women are found to be in the disease risk category in the illiterate group as per WC (35.8%), WHtR (57.9%), CI (70.4%), WHR (60.4%).

The relationship between WC, WHtR, CI and WHR with physical activity level is analysed in Table 5. Higher proportions of women are found to be normal or with no risk of disease in the moderate physical activity group as per WC (69.9%), WHtR (46.68%), CI (33.7%) and WHR (41.3%). Higher proportion of women are found to be in the disease risk category in the vigorous physical activity group as per WC (39.4%), WHtR (55.96%), CI (66.6%), WHR (60.2%).

The analysis of variance between and within the age groups, educational groups and physical activity groups (Table 6) reflects that according to age groups, the variance in WC, HC, WHtR, CI and WHR is significant. But as per level of education the variation is found to be significant only in case of WHtR and CI. When physical activity level is seen, the variation is significant in case of WC, HC and WHtR. The correlation between anthropometric variables with age, education and physical activity is shown in Table 7. Age is significantly correlated with WC, HC, WHtR, CI, WHR. Education is negatively correlated with all the anthropometric variables. Significant correlation is seen only in case of WHtR, CI, WHR. There is significant negative correlation of physical activity with WC, HC and WHtR.

Table 8 shows how the independent variables predict the variance in the dependent variables. Age and physical activity has been found to predict the dependent variables significantly.

Discussion

Till 50-54 years, the mean WC, HC and WHtR have been found to be increasing, and then it decreases slightly with the increase of age. The WC, HC and WHtR decrease by 2.74 cm, 4.52 cm and .02 cm respectively. Wannamethee *et al*, in 2005 has found that with age there is an increase in fat and decline in muscle. The loss in muscle might be the reason for the slight decrease in WC, HC and WHtR after reaching its peak at the age of 50 – 54 years. In the case of CI and WHR, the value increases steadily up to the last age group i.e. 60 years and above. The analysis of variance of all the variables between the age groups is statistically significant (at the level of 0.01) and a positive correlation exists between age and other anthropometric variables. This increase in circumference of the abdominal area and gluteoformal area in women may be due to the drop in estrogen levels that comes with menopause. In general, the natural menopause occurs between 45 and 55 years of age (WHO 1996). According to the Indian National Family Health Survey (NFHS-3)carried out during 2005-2006, about 18 per cent of currently married women in the age group of 30-49 years had reached menopause; a very similar finding of 17.7 per cent was reported in an earlier survey round (NFHS-2 1998-99). Among the women of the present study it occurs between the ages of 45 – 49 years (mean age at menopause 47.21 years) – (Table 2). Several studies have reported that adipose tissue distribution changes with age. Increasing age has been consistently associated with increased intra-abdominal adipose tissue deposition in both genders (Kotani *et al.* 1996 and Enzi *et al.* 1986). Studies have also documented age-related changes in adipose tissue distribution as reflected by an increase in the waist-to-hip ratio, which has been used as an anthropometric index of relative abdominal adiposity (Lanska *et al.* 1995; Tonkelaar *et al.* 1989). In the 1,179 participants of the Baltimore Longitudinal Study of Aging, a waist-to-hip ratio increase was reported across various age groups (from 17 to 96 years of age) in both men and women (Shimokata 1989).

Highest percentage of women of the age group 60 and above years is in the disease risk category as per WC, WHtR, CI and WHR. The percentage of women with disease risk increases from a younger age group to older age groups (Table 3). A 2008 study on more than 44,000 women for 16 years (Zhang *et al*. 2008) concluded that women with greater waist circumference were more likely to die of heart disease and cancer than those with smaller waists. Association of adiposity with metabolic risks was confirmed in a cross-sectional study (Christou *et al*. 2005). Abdominal fat comprises of both subcutaneous fat (fat that accumulates under the skin) and visceral adipose tissue (fat that accumulates around organs deep within the abdomen). Unlike subcutaneous fat, visceral fat cells release their metabolic products directly into the *circulatory system,* which carries blood straight to the liver. As a result, visceral fat cells that are enlarged and full of excess triglycerides pour fatty acids into the liver. Fatty acids also accumulate within the pancreas, heart, and other organs. The fatty acids accumulate in cells that aren't engineered to store fat. The result is organ dysfunction, which produces impaired regulation of insulin, blood glucose, and cholesterol, also as abnormal heart functions (Abdominal obesity and your health, 2017). In the present population, which is a rural one the women have a hard-working, physically active lifestyle. The women carry out household task as well as work in the orchards and collect firewood in nearby hills. They hardly sit and rest for less than 2 hours daily. All the women in the present study adhered to the recommended WHO guidelines for physical activity i.e. they do 150 minutes of moderate intensity physical activity or 75 minutes of vigorous-intensity activity or an equivalent combination of moderate and vigorous-intensity physical activity achieving at least 600 MET-minutes. But women who did vigorous activity showed the highest percentage in the disease risk category as per WC (39.4%), WHtR (55.96%), CI (66.6%) and WHR (60.2%). The mean WC, HC, WHtR also is high in case of women who did vigorous physical activity than among those who did moderate physical activity. The analysis of variance between the physical activity groups have been found to be significant in case of WC, HC and WHtR.

Sedentary behaviour increases in Asian Indians at around 35 to 45 years in women (Singh *et al.* 2007). This statement is highly contrary to the present study where the women starting from the age of 40 and above start to become more physically active as fewer women in this group have breastfeeding children and they can leave the children and go about their household work or working in the hills and fields. As it is seen in the present study, the waist circumference of the women increases as the age increases and subsequently puts them at risk for metabolic diseases. Since these women are also heavy workers this increasing waistline should not be a cause of concern for them as they burn a lot of calories while working. Moreover, physical activity questionnaires do not take into account free-living physical activity due to standing, moving around, and fidgeting and hence a lot of activity goes unreported, which if taken into account would increase the amount of activity done by a person. That means that they might still be fit with a lower risk of heart-related death. Vigorous physical activity might make them gain muscle and muscle weighs more than fat and it provides a significant boost to body metabolism (Thompson 2018). This muscle gains in the Garo women who perform vigorous physical activity might be making them muscular which is being misreported as obesity. Moreover, a negative correlation of physical activity with WC, HC, WHtR is seen of which WC and WHtR are significant at the 0.05 level and HC is significant at the 0.01 level. It means that WC, HC, WHtR significantly decreases with an increase in physical activity even though the high percentage of disease risk is seen with increasing physical activity.

The relationship of waist circumference to abdominal adiposity, especially visceral or intra-abdominal obesity, is age- and gender- as well as ethnicity-dependent (Hans *et al*., 1997; Lemieux *et al*., 1996; Despres *et al*., 2000; Misra *et al*., 2005). There is a continuous relationship between waist circumference and clinical outcomes, and these cut-off values of waist circumference (>80 cm – increased risk of metabolic complications and >88 cm – substantially increased risk of metabolic complications) are currently difficult to justify, especially if we consider that women have, on average, more subcutaneous fat and less visceral fat than men (Kvist, H. *et al*. 1986; Lemieux *et al*. 1993). However, menopause is associated with a selective deposition of visceral fat, a phenomenon which again makes the >80 cm and >88-cm value questionable (Kotani *et al*. 1994; Zamboni *et al*. 1992; Toth *et al*. 2000). Regarding ethnicity, the International Diabetes Federation (IDF) has recognized this problem and proposed to lower the waist circumference cut-offs for some ethnic groups (Alberti *et al*. 2005). The ethnic-specific cut-off values of abdominal and gluteofemoral obesity that they proposed were not generally approved against direct imaging data of visceral fat and clinical results, and further work is expected to characterize what is high-risk obesity in various populaces of the world. In spite of the fact that waist and hip circumferences and its derived measures is genuinely decent correspond of the measure of all abdominal fat, it can't recognize visceral adiposity, a significant correlate of metabolic irregularities, from the measure of subcutaneous abdominal fat. Numerous examinations have demonstrated that subcutaneous fat is making less partiality to the patient's metabolic profile while patients with an overabundance of visceral fat are portrayed by the worst metabolic profile (Despres 2006, 1990; Pouliot *et al*. 1992; Ross *et al*. 2000a, 2000b; Bjorntorp 1991; Goodpaster *et al*. 2003; Kissebah 1994; Matsuzawa *et al*. 1995; Nielsen and Jensen 1997). Thus, the anthropometric measures of abdominal and gluteofmoral obesity alone cannot distinguish between subcutaneous and visceral obesity. And thus, increased waistline doesn't always mean high-risk abdominal obesity. Moreover, the majority of the women of the present study claimed to be physically fit when asked to self-report their health status. No cases of heart-related ailments were reported from them. And on further investigation, the local pharmacists and health centres also have not registered any case which might have arisen due to fat deposition in the abdominal and gluteofemoral area.

The mean WC, HC, WHtR, CI shows a decreasing trend as the educational level increases. The highly literate women in the present population don't engage in heavy physical activities on daily basis as they are employed and do not need to depend only on agriculture for their living. Due to lack of heavy exercise in the form of household work and working in the hills and fields their body shape might be less muscular than their hard-working counterparts of the same age. Yoon *et al*. (2006)

found that higher levels of education for women resulted in lower waist circumference. Absence of statistically significant regression analysis in case of education prevents from drawing any conclusion on the role of education.

Conclusion

The mean of all the anthropometric variables shows an increasing trend with age, education and physical activity. Percentage of women in the disease risk category increases with age and decreases as the educational level increases. Waist circumference is found to be greater than 80 cm among the women who do vigorous physical activity. Numerous different studies have affirmed that increased adiposity is related to increased mortality and morbidity since the exemplary Framingham study was published. During the last few decades, examinations have furnished proof that subjects who do vigorous physical activity and have brought down mortality and lowered the danger of cardiovascular and metabolic sicknesses. Even though regular physical activity adds to the decrease of adiposity, numerous beneficial health effects from physical activity are free from its impact on adiposity. Besides, various studies propose that physical activity may offset the hazardous health effects of increased adiposity. This proposes that improvement of physical activity in an obese person may improve their health regardless of whether the person stays fat. The ability to perform physical activity is generally limited in obese people, but the women of the present study go about their daily work whether they are in the obese category or not. This might be because they do not have the luxury to maintain a sedentary lifestyle as the work they do is what comprises their livelihood or the women might not feel tired enough to not do any work. At last, the inquiry whether fat or fit is more significant may incline toward wellness however one should consider that an association of the two determinants is consistently present and in this way the individual effect is difficult to analyse.

References

Abdominal Obesity and your health. (2017). <https://www.health.harvard.edu/stayinghealthy/abdominal-obesity-and-your-health>. Accessed 12 September, 2020.

Alberti, K.G., Zimmet P., and Shaw J. (2005). "The metabolic syndrome – a new worldwide definition." *Lancet.* 366: 1059–1062.

Ashwell, M., and Hsieh S.D. (2005). "Six reasons why the waist-to-height ratio is a rapid and effective global indicator for health risks of obesity and how its use could simplify the international public health message on obesity." *International Journal of Food Sciences and Nutrition.* 56(5):303–307.

Beigaard, J., Frederiksen K., Tjonneland A., *et al.* (2004). "Waist and hip circumferences and all-cause mortality: usefulness of the waist-to-hip ratio." *International Journal of Obesity Related Metabolic Disorder*. 28:741–7.

Bjorntorp, P. (1991). "Metabolic implications of body fat distribution." *Diabetes Care*. 14:1132–1143.

Cameron, Adrian J., Romanuik Helena, Orellana Liliana, *et al.* (2020). "Combined influence of waist and hip circumference on risk of death in a large cohort of European and Australian adults." *Journal of American heart association*.

Canoy, D., Luben R., Welch A., Bingham S., Wareham N., Day N. *et al.* (2004). "Fat distribution, body mass index and blood pressure in 22090 men and women in the Norfolk cohort of the European prospective investigation into cancer and nutrition (EPIC Norfolk) study." *Journal of Hypertension* . 22: 2067–2074.

Christou, D. D., Gentile C. L., DeSouza C. A., Seals D. R., Gates P. E. (2005). "Fatness is a better predictor of cardiovascular disease risk factor profile than aerobic fitness in healthy men." *Circulation*. 111(15):1904-14.

Despres, J. P., Moorjani S., Lupien P.J. *et al.* (1990). "Regional distribution of body fat, plasma, lipoproteins, and cardiovascular disease." *Arteriosclerosis.* 10:497–511.

Després, J. P., Couillard C. Gagnon J. *et al.* (2000). Race, visceral adipose tissue, plasma lipids, and lipoprotein lipase activity in men and women: the Health, Risk Factors, Exercise Training, and Genetics (HERITAGE) family study. *Arteriosclerosis, Thrombosis, and Vascular Biology*. 20: 1932–1938.

Després, J. P. (2006). Is visceral obesity the cause of the metabolic syndrome? *Annals of Medicine*. 38:52– 63.

Enzi, G., Gasparo M., Biondetti P. R. *et al.* (1986). "Subcutaneous and visceral fat distribution according to sex, age, and overweight, evaluated by computed tomography." *American Journal of Clinical Nutrition*. 44: 739-46.

Goodpaster, B. H., Krishnaswami S., Resnick H., *et al.* (2003). "Association between regional adipose tissue distribution and both type 2 diabetes and impaired glucose tolerance in elderly men and women." *Diabetes Care*. 26:372–379

Grundy, S. M., Adams-Huet B., Vega G. L. (2008). "Variable contributions of fat content and distribution to metabolic syndrome risk factors." *Metabolic Syndrome Related Disorders* . 6: 281–288.

Han, T. S., McNeill G., Seidell J. C., Lean M. E. (1997). "Predicting intra-abdominal fatness from anthropometric measures: the influence of stature." *International Journal of Obesity Related Metabolic Disorders.* 21: 587–593.

Heitmann, B. L., and Frederiksen P. (2009). "Thigh circumference and risk of heart disease and premature death: prospective cohort study." *British Medicine Journal*. 339:b3292.

Indian Standard Classifcation of Education. (2014). Ministry of Education government of India. <https://www.mhrd.gov.in/indian-standard-classification-education>. Assessed 11 September, 2020

Kotani, K., Tokunaga K., Fujioka S., *et al.* (1994). "Sexual dimorphism of age-related changes in whole-body fat distribution in the obese." *International Journal of Obesity*. 18: 207-12.

Kvist, H., Ströström L., Tylen U. (1986). "Adipose tissue volume determinations in women by computed tomography: technical considerations." *International Journal of Obesity.* 10: 53–67.

Lanska, D.J., Lanska M.J., Hartz A.J., *et al.* (1985). "Factors influencing anatomic location of fat tissue in 52,953 women." *International Journal of Obesity*. 9: 29-38.

Lemieux, S., Prud'homme D., Bouchard C., Tremblay A., Després J. P. (1993). "Sex differences in the relation of visceral adipose tissue accumulation to total body fatness." *American Journal of Clinical Nutrition.* 58:463–467.

Lemieux, S., Prud'homme D., Nadeau A., Tremblay A., Bouchard C., Després J.P. (1996). "Seven-year changes in body fat and visceral adipose tissue in women. Association with indexes of plasma glucose-insulin homeostasis." *Diabetes Care.* 19: 983–991.

Lewis, M. Paul., Gary F., Simons, and Charles D. Fennig (eds.). (2013). *Ethnologue: Languages of the World*, 17th edition. Dallas, Texas: SIL International: 889,000 in India (2001 census), 120,000 in Bangladesh (2005). Population total all countries: 1,009,000.

Metabolic Syndrome. (2019). <https://www.nhlbi.nih.gov/health-topics/metabolic-syndrome>. Accessed 14 September, 2020.

Misra, A., Wasir J. S., Vikram N. K. (2005). "Waist circumference criteria for the diagnosis of abdominal obesity are not applicable uniformly to all populations and ethnic groups." *Nutrition.* 21: 969–976.

Manolopoulos, K. N., Karpe F., Frayn K. N. (2010). "Gluteofemoral body fat as a determinant of metabolic health."

International Journal of Obesity. 34: 949-959.

National Family Health Survey (NFHS-2), (1998-1999). India. Mumbai: IIPS; 2000. International Institute for Population Sciences (IIPS) and ORC Macro.

National Family Health Survey (NFHS-3), (2005-2006). India. I. Mumbai: IIPS; 2007. International Institute for Population Sciences (IIPS) and Macro International.

Neeland, I. J., Poirier P., Despres J. P. (2018). "Cardiovascular and metabolic heterogeneity of obesity: clinical challenges and implications for management." *Circulation*. 137:1391–1406.

Nielsen, S., Jensen M. D. (1997). "Obesity and cardiovascular disease: is body structure a factor?" *Current Opinion in Lipidology*. 8:200 –204.

Pitanga, F. J., and Lessa I. (2005). "Anthropometric Indexes of Obesity as an instrument of screening for high coronary risk in adults in the Salvador-Bahia." *Arquivos Brasileiros de Cardiologia*. 85: 01-05

Pouliot, M. C., Despre´s J. P., Nadeau A., Moorjani *et al.* 1992. "Visceral obesity in men. Associations with glucose tolerance, plasma insulin, and lipoprotein levels." *Diabetes*. 41:826 – 834.

Ross, R., Aru J., Freeman J., Hudson R., Janssen I. (2002). "Abdominal adiposity and insulin resistance in obese men." *American Journal of Physiology Endocrinology Metabolism*. 282:E657–E663.

Ross, R., Freeman J., Hudson R., Janssen I. (2002). "Abdominal obesity, muscle composition, and insulin resistance in premenopausal women." *Journal of Clinical Endocrinology Metabolism*. 87:5044 –5051.

Shimokata, H., Tobin J. D., Muller D. C. *et al.* (1989). "Studies in the distribution of body fat: I. Effects of age, sex, and obesity." *Journal of Gerontology.* 44: M66-73.

Singh, R. K., Pella D. *et al.* (2007). "Prevalence of obesity, physical inactivity and under nutrition, a triple burden of diseases during transition in a developing economy." *Acta Cardiologica*. 62(2):119-27

Stefan, N. (2020). "Causes, consequences, and treatment of metabolically unhealthy fat distribution." *Lancet Diabetes & endocrinology*. 8(7): 616-627.

Snijder, M. B., Zimmet P. Z., Visser M., Dekker J. M., Seidell J. C., Shaw J. E. (2004). "Independent and opposite associations of waist and hip circumferences with diabetes, hypertension and dyslipidemia: the Austra Diab Study. *International Journal of Obesity Related Metabolic Disorder*. 28:402–409

Son,Y. J., J. Kim, H.-J. Park *et al.* (2016). "Association of waist-height ratio with diabetes risk: a 4-year longitudinal retrospective study." *Endocrinology and Metabolism*. 31(1):127.

Thompson, Denis. (2018). Exercise makes even "still-overweight" healthier: study. Medical express.com. Accessed on 10 September, 2020

Tonkelaar, I.D., Seidell J.C., van Noord P.A., *et al.* (1989). "Factors influencing waist/hip ratio in randomly selected pre- and post-menopausal women in the dom-project (preliminary results)." *International Journal of Obesity*. 13: 817-24.

Toth, M. J., Sites C. K., Eltabbakh G. H., Poehlman E. T. (2000). "Effect of menopausal status on insulin-stimulated glucose disposal: comparison of middle-aged premenopausal and early postmenopausal women." *Diabetes Care.* 23: 801–806.

Valdez, R., Seidell J. C., Ahn Y. I. and Weiss K. M. (1993). "A new index of abdominal adiposity as an indicator of risk for cardiovascular disease: A cross-population study." *International Journal of obesity.* 17:77-82

Wannamethee, S. G., Shaper A. G., Lennon L. (2005). "Reasons for intentional weight loss, unintentional weight loss and mortality in older men." *Archives of Internal Medicine*. 165:1035-1040

WHO. (1996). Research on the menopause in the 1990s. Geneva:World Health Organization.

World Health Organisation (2002). "Global Physical Activity Questionnaire (GPAQ) Analysis Guide. Surveillance and population-based prevention of non-communicable diseases department."

WHO Expert Consultation. (2008). "Waist circumference and Waist-Hip ratio: Report." Geneva

WHO (2010). "Global recommendations on physical activity for health." Geneva, World Health

Organization.

Yoon, Y. S., Oh S. W., and Park H. S. (2006). "Socioeconomic Status in Relation to Obesity and Abdominal Obesity in Korean Adults: A Focus on Sex Differences." *Obesity*. 14:909 –919.

Yusuf, S., Hawken S., Ounpuu S., Bautista L., Franzosi M. G., Commerford P. *et. al.* (2005). "Obesity and the risk of myocardial infarction in 27000 participants from 52 countries: a case-control study." *Lancet*. 366: 1640–1649.

Zamboni, M., Armellini F., Milani M .P. *et al.* (1992). "Body fat distribution in pre- and post-menopausal women: metabolic and anthropometric variables and their inter-relationships." *International Journal of Obesity Related Metabolic Disorder.* 16: 495–504.

Zhang, C., Rexrode K. M., Van dam R. M., Li T. Y., Hu F. B. (2008). "Abdominal obesity and the risk of all-cause, cardiovascular, and cancer mortality: Sixteen years of follow-up in US women." *Circulation.* 117(13):1658-67.

Table 1: Descriptive statistics of anthropometric variables [waist circumference (WC), hip circumference (HC), Waist height ratio (WHtR), Conicity Index (CI), Waist Hip Ratio (WHR)].

Age	Total women	WC	HC	WHtR	CI	WHR
		± SD	± SD	± SD	± SD	± SD
≤ 19	60	69.98 ± 6.98	83.76 ± 6.05	.47 ± .05	1.17 ± .09	.84 ± .07
20 –24	100	72.18 ± 7.85	85.31 ± 6.31	.48 ± .05	1.18 ± .08	.85 ± .06
25 – 29	100	73.25 ± 8.34	85.80 ± 6.58	.49 ± .05	1.19 ± .08	.85 ± .53
30 – 34	93	77.38 ± 10.97	90.15 ± 8.61	.52 ± .07	1.21 ± .09	.86 ± .06
35 – 39	100	77.59 ± 9.99	90.24 ± 8.12	.52 ± .07	1.22 ± .09	.86 ± .05
40 – 44	82	77.94 ± 10.14	90.41 ± 8.10	.52 ± .07	1.22 ± .08	.86 ± .05
45 – 49	86	79.63 ± 10.99	90.51± 8.51	.54 ± .08	1.25 ± .11	.87 ± .05
50 – 54	80	82.79 ± 11.90	93.53 ± 8.91	.55 ± .08	1.27 ± .10	.88 ± .06
55 – 59	80	80.76 ± 11.48	90.07 ± 8.68	.54 ± .07	1.27 ± .13	.88 ± .07
60 ≤	81	80.05 ± 11.42	90.01 ± 9.37	.54 ± .08	1.28 ± .11	.89 ± .07
Educational level						
Illiterate/primary	159	78.36 ± 11.04	89.65 ± 8.32	.53 ± .07	1.25 ± .11	.87 ± .07
Middle/ Secondary	623	77.30 ± 10.49	89.41 ± 8.33	.52 ± .07	1.23 ± .10	.86 ± .06
Senior secondary/ Graduate and Post graduate	80	76.00 ± 11.25	88.38 ± 8.83	.50 ± .07	1.21 ± .10	.86 ± .06
Physical activity						
Moderate	392	76.32 ± 10.54	88.12 ± 8.42	.51 ± .07	1.23 ± .10	.86 ± .06
Vigorous	470	77.89 ± 10.83	90.10 ± 8.41	.52 ± .07	1.22 ± .10	.86 ± .06
Total	862					

Table 2: Distribution of women according to age at menopause

		No. of women by present age (years)		
Age at menopause	Total no. of women	40 – 44	45 – 49	50+
30 – 32	1(0.5)	1	-	-
33 – 35	1(0.5)	-	1	-
36 – 38	8(4.0)	3	1	4
39 – 41	13(6.5)	2	-	11
42 – 44	24(12.0)	1	7	16
45 – 47	65(32.5)	-	12	53
48 – 50	39(19.5)	-	4	35
51 – 53	25(12.5)	-	-	25
54 – 56	17(8.5)	-	-	17
57 – 59	7(3.5)	-	-	7
Total no. of women	200	7 (3.5)	25 (12.5)	168(84.0)
Mean age at menopause	47.21 ± 5.05	38.29	44.60	47.81

Figures within brackets are percentages

Table 3: Anthropometric measures of abdominal and gluteofemoral region as predictors of disease risk according to age groups.

Variables	Category	No. of women	≤ 19	20 - 24	25 - 29	30 - 34	35 - 39	40 - 44	45 - 49	50 - 54	55 - 59	60 ≤
WC	No risk	559(64.8)	56(93.3)	84(84.0)	82(82.0)	59(63.4)	61(61.0)	49(59.8)	46(53.5)	42(52.5)	41(51.3)	36(44.4)
	At risk	303(35.1)	4(6.7)	16(16.0)	18(18.0)	34(36.6)	39(39.0)	33(40.2)	40(46.5)	38(47.5)	39(48.8)	45(56.3)
WHtR	Normal	390(45.2)	44(73.3)	65(65.0)	64(64.0)	40(43.0)	38(38.0)	31(37.8)	32(37.2)	27(33.8)	25(31.3)	19(23.8)
	At risk	472(54.8)	16(26.7)	35(35.0)	36(36.0)	53(57.0)	62(62.0)	51(62.2)	54(62.8)	53(65.4)	55(68.8)	62(76.5)
CI	Normal	289(33.5)	35(58.3)	48(48.0)	47(47.0)	33(33.5)	32(32.0)	26(31.7)	21(24.4)	17(21.3)	15(18.8)	10(12.3)
	At risk	573(66.5)	25(41.7)	52(52.0)	53(53.0)	60(64.5)	68(68.0)	56(68.3)	65(75.6)	63(78.8)	65(81.3)	71(87.7)
WHR	No risk	350(40.6)	34(56.7)	53(53.0)	45(45.0)	38(40.9)	35(35.0)	28(34.1)	29(33.7)	27(33.7)	26(32.5)	24(29.6)
	At risk	512(59.4)	26(43.3)	47(47.0)	55(55.0)	55(59.1)	65(65.0)	54(65.8)	57(66.3)	53(66.3)	54(67.5)	57(70.4)
	Total	862	60	100	100	93	100	82	86	80	80	81

Table 4: Anthropometric measures of abdominal and gluteofemoral region as predictors of disease risk according to educational level.

Variables	Category	No. of women	Illiterate / primary	Middle and secondary	Senior secondary/ graduation/ post-graduation
WC	Normal	559(64.8)	102(64.2)	404(64.8)	53(66.3)
	At risk	303(35.1)	57(35.8)	219(35.1)	27(33.8)
WHtR	Normal	390(45.2)	67(42.1)	278(44.6)	45(56.3)
	At risk	472(54.8)	92(57.9)	335(53.8)	35(43.8)
CI	Normal	289(33.5)	47(29.6)	206(33.1)	36(45.0)
	At risk	573(66.5)	112(70.4)	417(66.9)	44(55.0)
WHR	Normal	350(40.6)	63(39.6)	248(39.8)	38(47.5)
	At risk	512(59.4)	96(60.4)	375(60.2)	42(52.5)
	Total	862	159	623	80

Table 5: Anthropometric measures of abdominal and gluteofemoral region as predictors of disease risk according to type of physical activity.

			Physical activity	
Variables	Category	No. of women	Moderate	Vigorous
WC	Normal	559(64.8)	274(69.9)	285(60.6)
	At risk	303(35.1)	118(30.2)	185(39.4)
WHtR	Normal	390(45.2)	183(46.68)	207(44.04)
	At risk	472(54.8)	209(53.32)	263(55.96)
CI	Normal	289(33.5)	132(33.7)	157(33.4)
	At risk	573(66.5)	260(66.3)	313(66.6)
WHR	Normal	350(40.6)	156(41.3)	194(39.8)
	At risk	512(59.4)	236(58.7)	276(60.2)
	Total	862	392	470

Table 6: Anova of anthropometric variables between and within the groups.

Variables	Age		Education		Physical activity	
	F	Sig.	F	Sig.	F	Sig.
WC	12.562	.000	1.056	.387	4.559	.033*
HC	12.692	.000	0.569	.755	11.773	.001*
WHtR	15.888	.000	2.148	.046*	6.500	.011*
CI	13.809	.000	3.463	.002*	.130	.718
WHR	5.596	.000	1.678	.123	.242	.623

Table 7: Correlation between anthropometric variables with age, education and physical activity.

Variables	WC	HC	WHtR	CI	WHR
Age(years)	.297**	.253**	.344**	.362**	.239**
education	-.061	-.025	-.101**	-.139**	-.087*
Physical activity	-.073*	-.116**	-.087*	.012	.017

**Correlation is significant at 0.05 level (2-tailed) **Correlation is significant at 0.01 level (2-tailed)*

Table 8: Regression coefficient between the variables

	Standardized coefficients	R^2		
	Beta		t	sig
WC				
constant		.723	11.463	.000
Age	.184		8.662	.000
Education	.011		.534	.593
Physical Activity	.083		4.459	.000
HC				
constant		.744	35.153	.000
Age	.131		6.380	.000
Education	.029		1.461	.144
Physical Activity	.027		1.499	.134
WHtR				
constant		.736	11.563	.000
Age	.222		10.685	.000
Education	-.011		-.531	.595
Physical Activity	.081		4.424	.000
CI				
constant		.219	35.35	.000
Age	.353		9.879	.000
Education	.009		.260	.795
Physical Activity	.139		4.440	.000
WHR				
constant		.259	42.250	.000
Age	.184		5.296	.000
Education	-.019		-.572	.567
Physical Activity	.128		4.188	.000