Human Biology Review
www.humanbiologyjournal.com

Human Biology Review (ISSN 22774424) 7(2) 2018
Original scientific paper (Chanak ad Bose pp. 183-204)
Revised and Accepted on April 22, 2018

Sexual dimorphism in central obesity among rural adults of Ghatal Block, Paschim Medinipur, West Bengal, India

M. Chanak[1] and K. Bose[2]

Citation: Chanak M and Bose K. 2018. Sexual dimorphism in central obesity among rural adults of Ghatal Block, Paschim Medinipur, West Bengal, India. Human Biology Review, 7 (2), 183-204.

[1]Mahua Chanak, Department of Anthropology, Vidyasagar University, Midnapore, 721102.
Email: mahua95@live.com
[2]Kaushik Bose, Department of Anthropology, Vidyasagar University, Midnapore, 721102.
Email: kaushikbose@cantab.net

Corresponding author: Kaushik Bose, Department of Anthropology, Vidyasagar University, Midnapore, 721102.Email: kaushikbose@cantab.net

ABSTRACT

Background: *Central obesity is a condition where an excessive abdominal fat has accumulated around the stomach and abdomen to an extent that it is likely to have a negative impact on health.* ***Aim:*** *Our study aimed to estimate the prevalence of central obesity and its association with family income (monthly) among the rural adults of Dirghagram village of Ghatal Block, Paschim Medinipur.* ***Subjects and methods:*** *The present cross-sectional study was conducted among 310 rural adults (154 males and 156 females) aged 18 years and above.* ***Results:*** *The female individuals showed higher prevalence of central obesity using waist circumference (cm), waist hip ratio, waist height ratio, and conicity index criteria than male individuals ($p<0.001$). In addition to that, one way ANOVA analysis and Chi-square (χ^2) test on most of the anthropometric and derived variables showed a statistically significant increase from low income group to high income group among both male and female participants ($p<0.001$;$p<0.01$; $p<0.05$).****Conclusion:*** Therefore, the present study showed a high prevalence of central obesity among the rural *adults of Dirghagram village. Furthermore, family income (monthly), a socio-economic factor contributed in increasingcentral obesity among the villagers.*

Key Words: *Central obesity, rural adults,waist circumference, waist hip ratio, waist height ratio, conicity index, monthly family income. .*

INTRODUCTION

Obesity:

Obesity can be defined either by increased waist circumference (WC), waist height ratio (WHtR), waist hip ratio (WHR) and/or body mass index (BMI). In developed and developing countries, as individuals consume more quantities of high-energy food and perform less physical activity, the number of overweight and obese individuals increase (WHO 2002).

According to the World Health Organization (WHO), obesity is one of the most common, yet among the most neglected public health problems in both developed and developing countries. According to the WHO World Health Statistics Report 2012, globally one out of six adults is obese and nearly 2.8 million individuals die each year due to being overweight or obesity. Obesity is strongly associated with increased risk of type 2 diabetes, dyslipidaemia, cardiovascular diseases, sleep apnea, osteoarthritis, depression, and even some cancers (Haslam and James, 2005; Luppino et al., 2010).Blood pressure levels and the prevalence of hypertension are related to adiposity, and the main components of adiposity are BMI, waist hip ratio (WHR), waist height ratio (WHtR) and percent body fat (PBF) (Kotchen et al., 2008).Obesity is generally classified into generalized obesity (BMI $\geq$30 kg/m^2) and abdominal obesity (WC $\geq$90 cm for men and WC $\geq$80 cm for women) based on World Health Organization recommendation for Asians (WHO 1995; WHO 2000). Higher rates of mortality and morbidity can be seen in individuals with obesity when compared to non-obese counterparts (Flegal et al., 2013; WHO 2009).

Central Obesity:

Abdominal obesity, also known as central obesity, is a condition where in excessive abdominal fat has accumulated around the stomach and abdomen to an extent that it is likely to have a negative impact on health. Cardiovascular disease is strongly correlated with central obesity (Yusuf et al., 2004).Central obesity is related to Alzheimer's disease as well as other vascular and metabolic diseases (Rozayet al., 2006). There is direct association of greater weight gain, specifically central obesity, even when accounting for calories with greater meat consumption (Vergnaudet al.,2010).Central obesity may develop at any age in both sexes and thereby increasing health problem but few scholars found in their study that the prevalence of central obesity is higher among females than male counterparts (Abolfotouh et al., 2008; Chauhan et al., 2015; Zhang et al., 2016).

Prevalence of both central obesity and generalized obesity in India:

In terms of population, India is the second most populous country in the world. With a population of 1.2 billion people, India is experiencing rapid epidemiological transition. Under-nutrition caused by poverty is being rapidly replaced by obesity associated to affluence (Mohan et al. 2006). India, like other developing countries, is steadily following a trend of becoming more obese. Due to India's continued integration in global food markets, population has gained more access to unhealthy, processed food. This, combined with rising middle class incomes, is increasing the average caloric intake per individual among the both middle class and above income families (Gulati and Misra, 2017).Lack of awareness is a very important cause for increasing obesity in India. In India, the major population still lacks basic knowledge about right nutrition. Industrialization and urbanization are the major contributing factors to the increased prevalence of obesity. Few studies from different parts of India have provided evidence of the rising prevalence of obesity (Mohan et al., 2006; Bhardwaj et al., 2011; Deepa et al., 2009; Misra et al., 2008).The prevalence of generalized obesity was 24.60%, 16.60%, 11.80% and 31.30% among residents of Tamilnadu, Maharashtra, Jharkhand and Chandigarh in India, while the prevalence of central obesity was 26.60%, 18.70%, 16.90% and 36.10%, respectively**.** Generalized to the whole country, 135 and 153 million individuals have general obesity andabdominal obesity, respectively. However, these figures have been estimated from three states (Tamil Nadu,Maharashtra, and Jharkhand) and one Union Territory (Chandigarh) of India and thereby, the results may be viewed in this light (Pradeepaet al., 2015).

Obesity is a major health problem in the present-day world. Worldwide, obesity is one of the major concerns in the urban areas. Central obesity is also a major health problem in the present-day world, which is directly associated with the mortality and morbidity among a population. The prevalence of central obesity is increasing dramatically worldwide. However, the impact of central obesity is comparatively less studied upon in the rural areas, and studies in rural areas having central obesity as a subject is hard to find. Globally there are numerous studies related to obesity and its consequences. In Indian context, though there is a good number of a study available on obesity, however the numbers of studies about central obesity among adults are considerably less. Similarly in West Bengal there is limited information available on central obesity among adults. Though, it is noteworthy to point out that, to date, there is no estimate of

the frequency of central obesity among rural adults of Ghatal Block, Paschim Medinipur, West Bengal. Hence, the present investigation is an endeavor to understand the central obesity situation of rural adults of Ghatal Block, Paschim Medinipur, West Bengal. This study aimed to estimate the prevalence of central obesity (based on WC, WHR, WHtR and CI) and its association with family income (monthly) among the rural adults of Dirghagram village of Ghatal Block, Paschim Medinipur, West Bengal.

METHODOLOGY

Study Area

The present cross-sectional study was undertaken among the villagers of Dirghagram under the Mansuka I gram panchayat of Ghatal Block, Paschim Medinipur, West Bengal.

Study Population

The data were collected from adult males and females of age group 18 to 86 years. A total of 310 adults (154 male and 156 female) were measured. The present study was conducted during March, 2017. A well structured schedule has been administered to collect socio-economic information (monthly family income) from each participant. Verbal consent has been taken from each participant before commencing of the study.

Anthropometric measures

Anthropometric measurements were taken by the first author (MC) using standard procedures according to Lohman et al (1988). Height (cm), weight (kg), waist circumference (WC) (cm), and hip circumference (HC) (cm) were measured. Intra-observer and inter-observer technical errors of the measurements (TEM) were calculated to determine the accuracy of the measurements using the standard procedure (Ulijaszek and Kerr, 1999). To calculate TEM, total of 50 adults, other than those covered in the present study were measured by the first author (MC). The TEM was calculated using the following standard equation:

$TEM=\sqrt{(\Sigma D^2/2N)}$, [D= Difference between the measurements, N= Number of individuals].

The coefficient of reliability (R) was calculated from TEM using the following standard equation:

$R= \{1-(TEM)^2/SD^2\}$ [SD= Standard deviation of the measurements].

The intra-observer and inter-observer TEM values were observed to be within the cut-off value (R=0.95) as recommended (Ulijaszek and Kerr, 1999). Hence, the measurements recorded in the present study were being reliable and reproducible.

Waist hip ratio (WHR), Waist height ratio (WHtR) and conicity index (CI) were derived by using following standard equations: WHR= waist circumference (cm) /hip circumference (cm); WHtR= waist circumference (cm) / height (cm); CI= waist circumference (m)/0.109√ [weight (kg)/height (m)] (Valdez et al., 1993).

To find out the prevalence of central obesity following standard cut-off values were used:

WC (cm.) ≥90 (male) and ≥80 (female) (WHO 2000).

WHR >0.95(male) and >0.85(female) (WHO 1989).

WHtR≥0.5 for both sexes (Hsieh and Muto, 2004).

CI≥1.25 (male) and ≥1.18 (female) (Flora et al., 2009).

Family income (monthly) was categorized by using tertiles (33.3^{th} and 66.7^{th}).Family income (monthly) was classified into three categories: Low income group (≤ 6999 INR), Medium income group (7000-14999 INR), High income group (≥15000 INR).

INR - Indian rupees

Statistical analyses

Descriptive statistics of all anthropometric characteristics by sex was computed. Independent sample t-test was performed to test the significant differences in mean anthropometric characteristic by sex of the studied population. One way ANOVA test was performed to test the significant difference in mean anthropometric variables with family income (monthly) groups among both sexes. Chi square (χ^2) test was also performed to test for significance difference in prevalence of nutritional status based on WHR, WHTR, and CI. All statistical analyses were undertaken by using the IBM SPSS Statistical Packages (version 16.0). The p-values of $p < 0.05$, $p < 0.01$ and $p < 0.001$ were considered to be statistically significant.

RESULTS

Descriptive statistics (Mean ±SD) of anthropometric and derived variables among studied participants are presented in ***Table 1***. The mean height and weight of males and females were

164.89 (±6.63) cm and 56.30(±9.62) kg; and 151.54 (±6.91) cm 50.03(±10.60) kg respectively. Mean WC (cm) was found to be more or less similar among both sexes (81.27in males and 81.80in females).Mean HC (cm) was higher in females (90.27cm) than in males (88.30cm). It was found that males had a statistically significant ($p<0.05$) higher mean WHR (0.92 ±0.06) than females (0.91 ±0.06). Similarly, mean WHtR was higher in females than in males (0.54 and 0.49) respectively. The mean values of CI also higher among the female (1.31 ±0.10) individuals than the males (1.28±0.09).By using independent sample t-test, it was observed that there were significant statistical differences between male and female individuals in height(cm) ($p<0.001$), weight (kg) ($p<0.001$),HC(cm) ($p<0.05$), WHR ($p<0.05$), WHtR ($p<0.001$) and CI ($p<0.01$).

The prevalence of central obesity among the studied participants is presented in ***Table 2***. Based on WC (cm) cut-offs,the prevalence of central obesity was higher in females than in males (55.8% and 19.5% respectively).Similarly, WHR showed a higher prevalence in females than in males (87.2% and 35.7% respectively).Based on WHtR cut-offs, it was observed that female participants had a higher prevalence of central obesity than males (73.7% and 44.2% respectively).On the basis of CI cut-offs considered in present study, females were more centrally obese than males (87.2% and 57.8% respectively).The overall result of the table demonstrated a highly significant ($p<0.001$) association between sex and central obesity.

The anthropometric and derived variables among different family income groups in male participants are depicted in ***Table 3a***. It has been observed that among male participants the mean height (cm), weight (kg), WC (cm), HC (cm), WHR, WHtR, CI increased from low income group to high income group. Using ANOVA, it has been observed that significant differences in height (cm) ($p<0.05$), Weight (kg) ($p<0.01$), WC (cm) ($p<0.001$), HC (cm) ($p<0.01$), WHR ($p<0.05$), WHtR ($p<0.01$) and CI ($p<0.05$) between the low income group (≤6999 INR), medium income group (7000-14999 INR), and high income group (≥15000 INR).

The same analysis in female participants is presented in ***Table 3b***. It has been observed that among female participants the mean height (cm), weight (kg), WC (cm), HC (cm), WHR, WHtR, CI increased from low income group to high income group. Using ANOVA, it has been observed that significant differences in weight (kg) ($p<0.01$), WC (cm) ($p<0.001$), HC (cm) ($p<0.01$), WHtR ($p<0.01$) and CI ($p<0.05$) between the low income group (≤6999 INR), medium income group (7000-14999 INR), and high income group (≥Rs. 15000 INR). However,

differences in height (cm.) and WHR were not statistically significant between these three categories.

The monthly income wise prevalence of central obesity among the studied participants is presented in ***Table 4***. This table indicated that the prevalence of central obesity increased from low income group to high group among both sexes. While considering CI, it was observed that in males the prevalence of central obesity was similar in both low income group (50.0%) as well as high income group (50.8%). In addition to that, WC (cm) had a significant association with family income (monthly) among males ($p<0.001$) and females ($p<0.05$).WHR and WHtR had significant association with family income among males ($p<0.05$; $p<0.01$ respectively).The CI had a significant association with family income (monthly) among males ($p<0.05$) as well as females ($p<0.01$).

DISCUSSION

The present study evaluated that the anthropometric assessment of central obesity among rural adults of Ghatal Block, Paschim Medinipur, West Bengal. It demonstrated that females were more centrally obese than males based on WC (55.8% females and 19.5% males), WHR (87.2% females and 35.7% males), WHtR (73.7% females and 44.2% males) and CI (87.2% females and 57.8% males). A highly significant association existed between sex and central obesity ($p<0.001$).In addition to that, one way ANOVA analysis and Chi-square (χ^2) test on most of the anthropometric and derived variables showed a statistically significant increase from low income group to high income group among both male and female participants ($p<0.001$; $p<0.01$; $p<0.05$).Therefore the present study revealed that the family income (monthly) was associated with increasing central obesity among both sexes (males and females).

Numerous studies (Abolfotouh et al., 2008; Veghari et al., 2016;Bakiret al., 2017;Goon et al., 2014;Chauhan et al., 2015) have been done in different parts of world(Egypt, Iran, Syria, South Africa, India) on the prevalence of central obesity and they have revealed significantly higher prevalence of central obesity in females than males. Most of the studies have used WC (cm) and WHR parameter to evaluate the prevalence of central obesity among adults. On the basis of WC (cm) and WHR the prevalence of central obesity ranged from 31.4% to 96.0% and 43.5% to 100.0% respectively. The present study showed 55.8% and 87.2% females were

centrally obese when used both WC (cm) and WHR cut-offs which corroborate with the earlier studies.

In the present study, it was observed that females were more centrally obese (WHtR and WC) than males but some scholars found in their studies that males had higher prevalence of central obesity than females when WHtR (Lopez-Sobaleret al., 2016; Goon et al., 2014) and WC (cm) (Nalawade et al., 2012) were utilized andthese findings werein contradiction with the present study.

In our study, there were three income groups, low income group (≤6999 INR), medium income group (7000-14999 INR) and high income group (≥15000 INR).Mean height (cm), weight (kg), WC (cm), HC (cm), WHR, WHtR, CI increased from low income group to high income group among both sexes ***(Tables 3a and 3b)***.Central obesity has shown a significant increase in accordance with the family income(monthly)***(Table 4)***. Similar results were also observed in some of the earlier studies (Basuet al., 2013; Pradeepaet al., 2015). However, some studies have reported that central obesity increased in lower income groups(Sousaet al., 2011; Wu et al., 2014) and a few others have reported that the middle income groups (Zhang et al., 2016) had higher central obesity. Yi et al. (2017) and Yoon et al. (2006) independently studied Chinese adults and Korean adults respectively and reported that females with high income presented a relative decrease of central obesity but in case of males, central obesity increased from low income group to high income group. In present study it has been clearly observed that, central obesity in both sexes, were closely associated with their level of economy. The reason behind the phenomenon was consumption of high calorie food as abundant availability and comparatively less energy expenditure as required (Monteiro et al., 2001; Yoon et al., 2006).Therefore, on the basis of findings of the present study, we can confirm that income (monthly) is a risk factor for central obesity.

To compare our present study with other studies ***(Tables 5 and 6)***, it has been observed in most of the studies Egypt (Abolfotouh et al., 2008), Iran (Veghari et al., 2016), South Africa (Goon et al., 2014), Bangladesh (Siddiquee et al., 2015) and India (Chauhan et al., 2015) the number of centrally obese (WC and WHR) females were higher than males ***(Figures 2 and 3)***. Figure 2 demonstrated the females of India (Chauhan et al., 2015) were highest in prevalence of central obesity in respect of WC (65.7%) followed by females of the present study (55.8%) and the Iranian females (54.4%).On the other hand males have shown consistently lower prevalence

in comparison to females in all the studies mentioned ***(Figure 2)***.In this context, the present study demonstrated the prevalence of central obesity (WHR) among female adults (87.2%) was higher in comparison to the other countries ***(Figure 3)***.Bangladesh (Siddiquee et al., 2015) has shown the second highest prevalence (79.1%) on female central obesity. Iranian adult (Turkman and non-Turkman) males (62.7%) and females(63.1%) have shown almost equal prevalence of central obesity (WHR).In Indian context, interestingly a study conducted in West Bengal (Sarkar et al., 2009) showed 100.00% central obesity (WHR) among both sexes. The present study revealed the lowest prevalence of male central obesity i.e. 35.7% followed by Karnataka adult males (36.8%) ***(Figure 4)***.

CONCLUSION

In conclusion, the main findings of the present study may be summarized as follows:

1. Overall prevalence of central obesity based on WC (cm), WHR, WHtR and CI among the rural adults of Dirghagram village, Paschim Medinipur, West Bengal was 37.7%, 61.6%, 59.0% and 72.6% respectively. The prevalence of central obesity was higher among females than males based on WC (55.8% females and 19.5% males), WHR (87.2% females and 35.7% males), WHtR (73.7% females and 44.2% males) and CI (87.2% females and 57.8% males); there was a highly significant association between sex and central obesity.
2. Mean height (cm), weight (kg), WC (cm), HC (cm), WHR, WHtR and CI increased from low income group to high income group in both sexes. The prevalence of central obesity increased with monthly family income among both sexes and monthly family income was significantly associated with central obesity among both sexes except WHR and WHtR among females.

The present study highlighted the problem of central obesity among rural adults, especially among females which may have serious public health implications. Government and health department should put an effort to improve people's awareness of central obesity among rural adults. There should be increased awareness about performing physical activity and limiting consumption of high energy food in daily life of people.

ACKNOWLEDGEMENTS

The authors gratefully acknowledged to all the participants of Dirghagram village for their cooperation and patience. Authors would like to acknowledge the Department of Anthropology, Vidyasagar University, Midnapore for providing necessary support to conduct the fieldwork. The authors would also like to express their thanks to Soma Pal, Dr. Koel Mukherjee,

Pratim Roy for their support and cooperation.The financial assistance of the University Grants Commission (Government of India) under the Special Assistance Programme (SAP) is also acknowledged.

Research Funding: University Grants Commission (Government of India) under the Special Assistance Programme (SAP)

Statement of Conflict: The authors declare no conflict of interest.

Authors Contributions: MC designed the study and collected the data. Data entry and analyses were performed by her. She also prepared and edited the manuscript. KB designed the study, analysed the data and edited the manuscript.

REFERENCES

1. Abolfotouh MA, Soliman LA, Mansour E, Farghaly ME and Dawaiaty AA. 2008. Central obesity among adults in Egypt: prevalence and associated morbidity.*East Mediterr Health J*, **14**: 57-68.
2. Bakir MA, Hammad K, Mohammad L. 2017. Prevalence of obesity, central obesity, and associated socio-demographic variables in Syrian women using different anthropometric indicators.*Anthropol Rev*,**80**: 191–205.
3. Basu G,Baur B,Mondal S,Chatterjee C,Saha D,Roy SK. 2013. Risk Factors of Obesity among 15-64 Yrs Age Group: Picture in a Village of West Bengal. *IOSR-JDMS*, **6**: 1-7.
4. Bhardwaj S, Misra A, Misra R, Goel K, Bhatt SP, Rastogi KV. 2011. High prevalence of abdominal, intra-abdominal and subcutaneous adiposity and clustering of risk factors among urban Asian Indians in North India. *PLoS One*,**6**: e24362.
5. Bindhu A, Thankam K, Jose R, Benny PV, Beevi N, Haran JC. 2014.Prevalence of obesity and overweight among adults in a rural area in Trivandrum-a cross sectional study.*Int J Prev Ther Med*, **2**:1-4.
6. Chauhan RC, Chauhan NS, Manikandan, Purty AJ, Mishra AK and Singh Z. 2015. Obesity among adult population of a rural coastal area in South India. *Int J Sci Rep*, **1:155**-158.
7. Deepa M, Farooq S, Deepa R, Manjula D, Mohan V. 2009. Prevalence and significance of generalized and central body obesity in an urban Asian Indian population in Chennai, India (CURES: 47). *Eur J Clin Nutr*,**63**:259-267.

8. Flegal KM, Kit BK, Orpana H, Graubard BI. 2013. Association of all-cause mortality with overweight and obesity using standard body mass index categories: a systematic review and meta-analysis. *JAMA*, **309**:71–82.
9. Flora MS, Massie-Taylor CGN, Rahman M. 2009.Conicity Index of adult Bangladeshi population and their socio-demographic characteristics. *Ibrahim Med Coll J*, **3**:1-8.
10. Goon DT, Maputle MS,Olukoga A, Lebese R, Khoza LB, Mothiba TM. 2014. Anthropometrically determined abdominal obesity among nurses in Vhembe and Capricorn Districts, Limpopo, South Africa. *Biomed Res*, **25**: 567-572.
11. Gulati S, Misra A. 2017.Abdominal obesity and type 2 diabetes in Asian Indians: Dietary strategies including edible oils,cooking practices and sugar intake. *Eur J Clin Nutr*, 71:850-857.
12. Haslam DW, James WP.2005. Obesity. *Lancet*, **366**: 1197-1209.
13. Hsieh SD, Muto T. 2004. A simple and practical index for assessing the risk of metabolic syndrome during the routine heath checkups. *Nippon Rinsho*, **62**: 1143-1149.
14. Kaur J, Singh M, Pal Singh Batra A, Garg R, Kaur M and Punia N. 2013. Blood pressure and obesity variation among population of Amritsar district. *Int J of Basic App Med Sci*, **3:**113-121.
15. Kotchen T.A., Grim C.E., Kotchen J.M., Krishnaswami S., Yang H., Hoffmann R.G. and McGinley E.L. 2008. Altered relationship of blood pressure to adiposity in hypertension. *Am J Hypertens*, **21**: 284-289.
16. Lohman TG, Roche AF, Martorell R. 1988. *Anthropometric Standardization Reference Manual*. Human Kinetics Books: Chicago, IL.
17. Lopez-Sobaler AM, Aparicio A, Aranceta-Bartrina J, Gil A, Gonzalez-Gross M, Serra-Majem L, Varela-Moreiras G and Ortega RM. 2016. Overweight and general and abdominal obesity in a representative sample of Spanish adults: findings from the ANIBES study. *Biomed Res Int*, **2016**:8341487.
18. Luppino FS,de Wit LM,Bouvy PF,Stijnen T,Cuijpers P,Penninx BW, Zitman FG. 2010. Overweight, obesity, and depression: a systematic review and metaanalysis of longitudinal studies. *Arch Gen Psychiatry*, **67**: 220-229.
19. Misra A, Khurana L. 2008. Obesity and the metabolic syndrome in developing countries. *J Clin Endocrinol Metab*, **93**: S9-30.

20. Mohan V, Deepa R. 2006. Obesity & abdominal obesity in Asian Indians. *Indian J Med Res*, **123**: 593-596.

21. Monteiro CA, Conde WL, Popkin BM**.** 2001. Independent effects of income and education on the risk of obesity in the Brazilian adult population. *J Nutr*,**131**:881S– 886S.

22. Nagendra K, Nandini C, Belur M. 2017. A community based study on prevalence of obesity among urban population of Shivamogga, Karnataka, India. *Int J Community Med Public Health*, **4**:96-99.

23. Nalawade S, Prabhu D. 2012. Prevalence of Obesity and Abdominal Obesity in Working Adults of Mumbai Population. *Int J Med Sci*, **5**: 52-54.

24. Pradeepa R, Anjana RM, Joshi SR, Bhansali A, Deepa M, Joshi PP, Dhandania VK, Madhu V, Rao PV, GeethaL, Subashini R, Unnikrishnan R, Shukla DK, Kaur T, Mohan V, Das AK. 2015. Prevalence of generalized & abdominal obesity in urban and rural Indian-the ICMR-INDIAB Study (Phase-I) [ICMR-INDIAB-3]. *Indian J Med Res*, **142**:139-150.

25. Razay G, Vreugdenhil A, Wilcock G. 2006. Obesity, abdominal obesity and Alzheimer disease. *Dement Geriatr Cogn Dis*, **22**:173–176.

26. Sarkar D, Mondal N and Sen J. 2009. Obesity and blood pressure variations among the Bengali Kayastha population of North Bengal, India.*J Life Sci*, **1**: 35-43.

27. Siddiquee T, Bhowmik B, Da Vale Moreira NCDV, Mujumder A, Mahtab H, Khan AKA, Hussain A. 2015. Prevalence of obesity in a rural Asian Indian (Bangladeshi) population and its determinants. *BMC Public Health*, **15**:860.

28. Sousa TF, Nahas MV, Silva DAS, Duca GFD, Peres MA. 2011. Factors associated with central obesity in adults from Florainopolis,Santa Caterina:a population based study. *Rev Bras Epidemiol*, **14:**296-309.

29. Ulijaszek SJ, Kerr DA. 1999. Anthropometric measurement error and the assessment of nutritional status. *Bri J Nutr*, **82**: 165-177.

30. Valdez R, Seidell JC, Ahn YI, Weiss KM.1993.A new index of abdominal adiposity as an indicator of risk for cardiovascular disease. A cross-population study.*Int J Obes Relat Metab Disord*, **17**:77-82.

31. Veghari G, Sedaghat M, Banihashem S, Moharloei P, Angizeh A, Tazik E, Moghaddami A, Kordi K, Honarvar MR. 2016. Prevalence of general, abdominal and waist-to-hip

ratio obesity among adults in the north of Iran: An ethnical comparative study. *Int J Med Res Health Sci*, **5**:219-225.

32. Vergnaud AC, Norat T,Romaguera D,Peeters PHM. 2010. Reply to A Astrup et al. *Am J Clin Nutr*, **92**:1275-1276.
33. Vergnaud AC, Norat T,Romaguera D,MouwT,MayAM,TravierN,LuanJ, WarehamN,SlimaniN, Rinaldi S, Couto E, Clavel-Chapelon F,Boutron-Ruault MC, Cottet V, Palli D, Agnoli C, Panico S, Tumino R,Vineis P, Agudo A, Rodriguez L, Sanchez MJ, Amiano P, Barricarte A,Huerta JM, Key TJ, Spencer EA, Bueno-de-Mesquita B, Buchner FL,Orfanos P, Naska A, Trichopoulou A, Rohrmann S, Hermann S, Boeing H, Buijsse B, Johansson I, Hellstrom V, Manjer J, Wirfalt E, Jakobsen MJ,Overvad K, Tjonneland A, Halkjaer J, Lund E, Braaten T, Engeset D, Odysseos A,Riboli E, PeetersPHM. 2010.Meat consumption and prospective weight change in participants of the EPIC-PANACEA study.*Am J Clin Nutr*, **92**:398-407.
34. World Health Organization (WHO).1989. *Measuring obesity: classification and description of anthropometric data*.Reporton a WHO consultation on the epidemiologyof obesity, Warsaw, 21–23 October1987. Copenhagen: World Health OrganizationRegional Office for Europe.
35. World Health Organization (WHO). 1995. *Physical status: The use of and interpretation of anthropometry*. Report of a WHO Expert Committee. Technical Report Series no. 854. Geneva: World Health Organization.
36. WHO/IASO/IOTF. 2000.*The Asia-Pacific perspective: redefining obesity and its treatment*. Melbourne: Health Communications Australia.
37. World Health Organization (WHO).2002. *The world health report 2002- reducing risks, promoting healthy life*. Geneva: World Health Organization.
38. World Health Organization (WHO). 2009. *Global health risks: mortality and burden of disease attributable to selected major risks*. Geneva: World Health Organization.
39. World Health Organization (WHO). 2012. World Health Statistics 2012. Geneva:World Health Organization.
40. Wu S, Wang R, Jiang A, Ding Y, Wu M, Ma X, Zhao Y, He J. 2014. Abdominal obesity and its association with health-related quality of life in adults: a population-based study in five Chinese cities. *Health Qual Life Outcomes,* **12**:1-11.

41. Yi Z, Yun, YU FH, Tao YU, Mei YD, Yun ZL, Feng LX, Hua ZW. Changes in waist circumference and abdominal obesity among Chinese adults over a ten-year period. *Biomed Environ Sc*, **30**: 315-322.
42. Yoon YS, Oh SW, Park HS. 2006. Socioeconomic status in relation to obesity and abdominal obesity in Korean adults: A focus on sex differences. *Obesity*, **14**: 909-919.
43. Yusuf S, Hawken S, Ounpuu S, Dans T, Avezum A, Lanas F, McQueen M, Budaj A, Pais P, Varigos J, Lisheng L, INTERHEART Study Investigators. 2004. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case-control study. *Lancet*, **364**:937–952.
44. Zhang P, Wang R, Gao C, Jiang L, Lv X, Song Y, Li B. 2016. Prevalence of central obesity among adults with normal BMI and its association with metabolic diseases in Northeast China. *PLoS ONE*, **11**:1-10.

Table 1: Descriptive statistics (Mean±SD) of anthropometric and derived variables among the participants

Anthropometric Variables	Sex	n	Mean ± SD	t	p-value
Height(cm)	Male	154	164.89 ± 6.63	17.354	.000***
	Female	156	151.54 ± 6.91		
Weight(kg)	Male	154	56.30 ± 9.62	5.453	.000***
	Female	156	50.03 ± 10.60		
WC (cm)	Male	154	81.27 ± 8.52	-.469	.640N
	Female	156	81.80 ± 11.05		
HC(cm)	Male	154	88.30 ± 6.52	-2.071	.039*
	Female	156	90.27 ± 9.86		
Derived variables					
WHR	Male	154	0.92 ± 0.06	2.141	.033*
	Female	156	0.91 ± 0.06		
WHtR	Male	154	0.49 ± 0.05	-6.733	.000***
	Female	156	0.54 ± 0.07		
CI	Male	154	1.28 ± 0.09	-2.766	.006**
	Female	156	1.31 ± 0.10		

n =Sample size, ± Standard deviation.

*** p<0.05, ** p<0.01, *** p<0.001 and N=Not significant.**

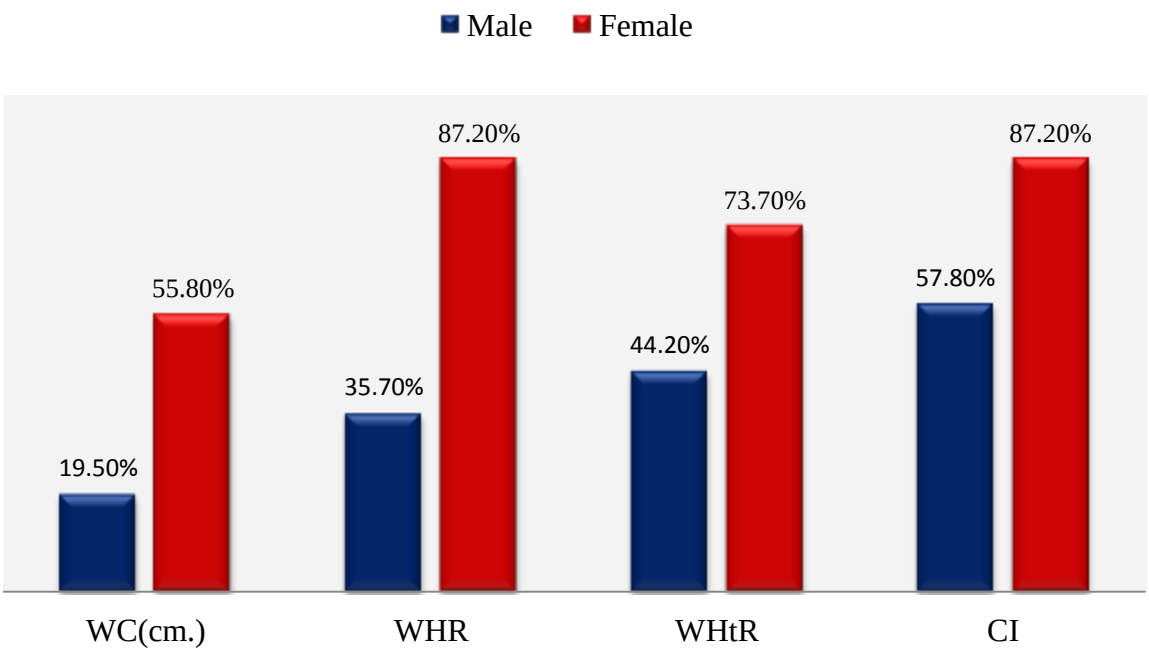
Table 2: Prevalence of central obesity among the participants.

Variables	Male	Female	Total	χ^2	p-value
WC(cm.)	30 (19.50)	87 (55.80)	117(37.70)	43.432	.000***
WHR	55 (35.70)	136 (87.20)	191(61.60)	86.787	.000***
WHtR	68 (44.20)	115 (73.70)	183(59.00)	28.004	.000***
CI	89 (57.80)	136 (87.20)	225(72.60)	33.630	.000***

Percentages are presented in the parenthesis.

***** p<0.001**.

Figure 1:Prevalence of central obesity among the participants



3a: Descriptive statistics (Mean±SD) of anthropometric and derived variables among different family income groups in male participants.

Variable	Low Income Group (≤6999 INR)	Medium Income Group (7000-14999 INR)	High Income Group (≥ 15000 INR)	F	p-value
Height (cm.)	162.82±5.24	164.79 ± 6.79	166.73 ±7.03	4.003	.020*
Weight (Kg.)	52.82 ±8.37	55.48 ±8.38	60.24 ±10.86	7.545	.001**
WC (cm.)	77.76 ±6.18	80.39 ±8.46	85.31 ±8.79	10.360	.000***
HC (cm.)	86.10 ±5.30	87.65 ±6.31	90.97 ±6.90	7.293	.001**
WHR	0.90 ± 0.06	0.92 ± 0.06	0.94 ±0.06	3.527	.032*
WHtR	0.48 ±0.04	0.49 ±0.05	0.51 ±0.05	5.783	.004**
CI	1.26 ±0.08	1.27 ± 0.09	1.31 ±0.09	3.788	.025*

± Standard deviation
* **p<0.05,** ** **p<0.01,** *** **p<0.001**.

Table 3b: Descriptive statistics (Mean± SD)of anthropometric and derived variables among different family income groups in female participants.

Variable	Low Income Group (≤6999 INR)	Medium Income Group (7000-14999 INR)	High Income Group (≥ 15000 INR)	F	p-value
Height (cm.)	151.40 ±6.70	150.01 ± 6.43	153.85 ± 7.28	2.448	.090^{N}
Weight (Kg.)	46.39 ±8.20	48.46 ±8.18	53.62 ± 12.53	7.176	.001**
WC (cm.)	76.83 ± 9.70	81.29 ±10.53	85.38 ±11.11	8.272	.000***
HC (cm.)	86.22 ± 8.25	89.75 ±8.61	93.28 ±10.81	7.016	.001**
WHR	0.89 ± 0.05	0.90 ± 0.06	0.92 ±0.06	2.491	.086^{N}
WHtR	0.51 ± 0.06	0.54 ±0.07	0.56 ±0.07	7.364	.001**
CI	1.28 ±0.10	1.31 ± 0.10	1.33 ± 0.10	3.074	.024*

± Standard deviation

*p<0.05, ** p<0.01, *** p<0.001 and N=Not significant.

Table 4: Monthly family income wise distribution of central obesity among the studied participants.

Variables		Low Income Group (≤6999 INR)	Medium Income Group (7000-14999 INR)	High Income Group (≥15000 INR)	Total	χ^2	p-value
WC(cm.)	**Male**	2 (5.00)	10 (15.40)	18 (36.70)	30 (19.50)	15.342	0.000***
	Female	16 (39.00)	27 (52.90)	44 (68.80)	87 (55.80)	9.198	0.010*
WHR	**Male**	10 (25.00)	21 (32.30)	24 (49.00)	55 (37.50)	6.084	0.048*
	Female	32 (78.00)	44 (86.30)	60 (93.80)	136 (87.20)	5.568	0.062 ^{N}
WHtR	**Male**	12 (30.00)	25 (38.50)	31 (63.30)	68 (44.20)	11.362	0.003**
	Female	25 (61.00)	39 (76.50)	51 (79.70)	115 (73.70)	4.813	0.090 ^{N}
CI	**Male**	20 (50.00)	33 (50.80)	36 (73.50)	89 (57.80)	7.247	0.027*
	Female	30 (73.20)	46 (90.20)	60 (93.80)	136 (87.20)	10.086	0.006**

Percentages are presented in the parenthesis.

* p<0.05, ** p<0.01, *** p<0.001, N=Not significant.

Table 5: Prevalence of central obesity (WC & WHR): Worldwide.

Study population	Study area	Sample	Age (years)	Sex	Prevalence (%) of central obesity		Reference
					WC (cm)	WHR	
Egyptian adults	Egypt	1800	18 and above	M	14.00	12.40	Abolfotouh et al., 2008
				F	34.10	44.90	
Turkman & Non-Turkman	Iran (North)	464	15-70	M	22.90	62.70	Veghari et al., 2016
				F	54.40	63.10	
Adult nurses (both sexes)	Vhembe and Capricorn, South-Africa	153	19-50^{+}	M	18.90	37.20	Goon et al., 2014
				F	49.70	43.80	
Rural Bangladeshi	Chandra, Bangladesh	2,293	20 and above	M	24.30	58.40	Siddiquee et al., 2015
				F	48.70	79.10	
Rural coastal adults	Tamilnadu, India	207	15 and above	M	31.30	50.00	Chauhan et al., 2015
				F	65.70	60.10	
Rural adults	**West Bengal,India**	310	18 and above	M	19.50	35.70	**Present study**
				F	55.80	87.20	

M=Male, F=Female.

Figure 2: Comparison of prevalence of central obesity (WC) with other global studies.

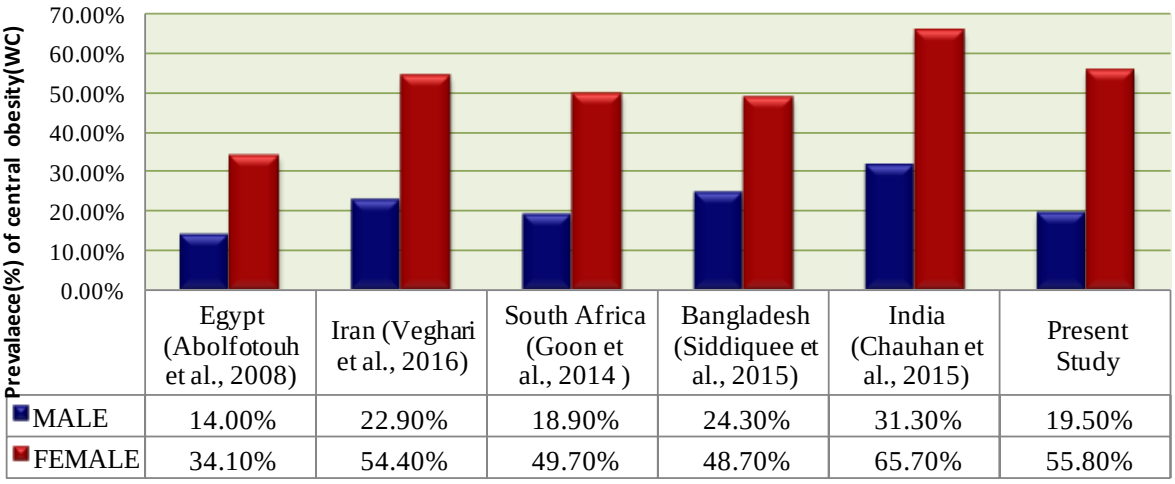


Figure 3: Comparison of prevalence of central obesity(WHR) with other global studies

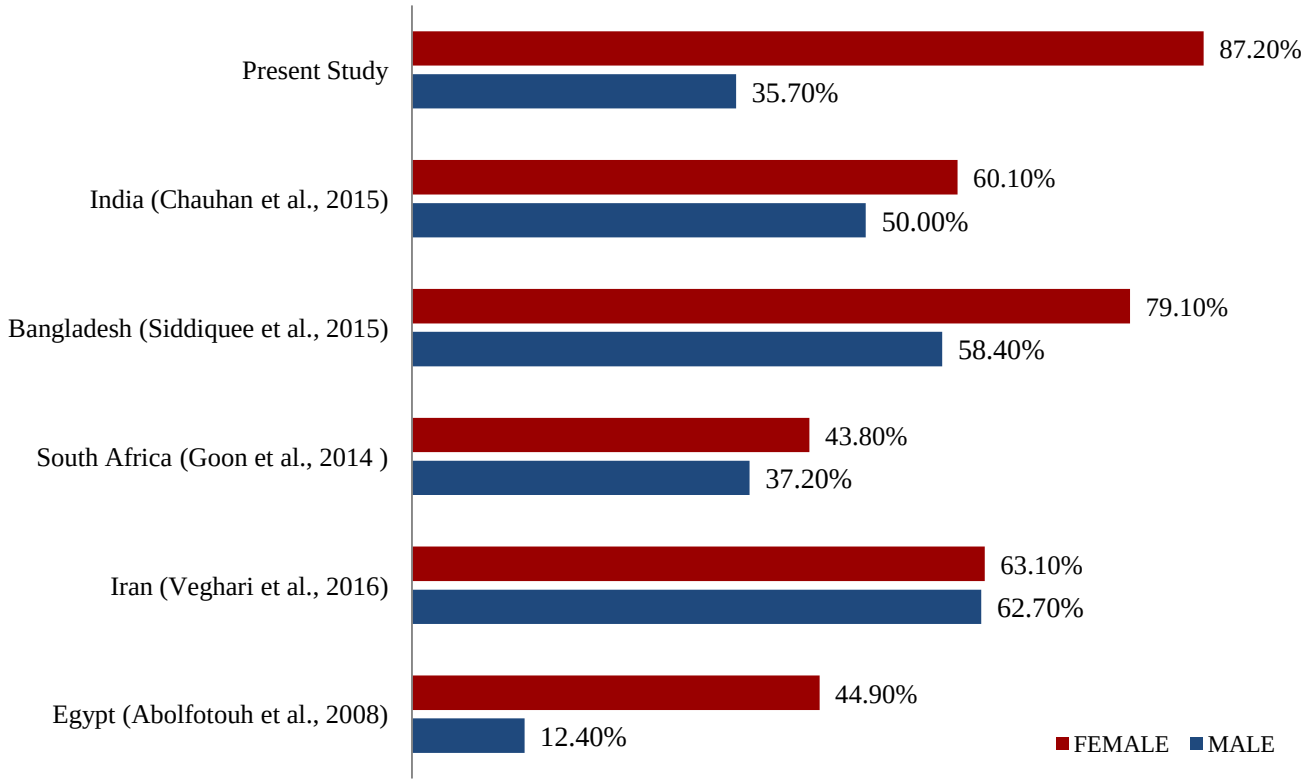


Table 6: Comparison of central obesity (WHR) prevalence among Indian adults and the present study.

Study population	**Study area (state)**	**Sample**	**Age (years)**	**Sex**	**Prevalence (%) of central obesity (WHR)**	**Reference**
Punjabi adults	Amritsar, Punjab	400	30-50	M	73.00	Kaur et al., 2013
				F	93.50	
Mumbai working adults	Mumbai, Maharashtra	1,946	21-45	M	53.50	Nalawade and Prabhu, 2012
				F	47.90	
Rural coastal adults	Villupuram,Tamilnadu	207	15 and above	M	50.00	Chauhan et al., 2015
				F	60.10	
Urban adults	Shivamogga, Karnataka	2,000	15-64	M	36.80	Nagendra et al., 2017
				F	45.60	
Rural adults	Trivandrum, Kerala	224	18 and above	M	48.50	Bindhu et al., 2014
				F	77.70	
Bengali Kayastha	Jalpaiguri, West Bengal	155	30-50	M	100.00	Sarkar et al., 2009
				F	100.00	
Rural adults	**Paschim Medinipur, West Bengal**	**310**	**18 and above**	**M**	**35.70**	**Present Study**
				F	**87.20**	

M=Male, F=Female.

Figure 4: Comparison of central obesity (WHR) prevalence among Indian adults and the present study