Study on prevalence of obesity using different scales and its association with hypertension among the elderly in a district of Gujarat

Noopur Nagar¹, Shashwat Nagar², Niraj Bharadva³, Hiren B. Patel², Darshan Mahyavanshi³, Sunita S. Nagar⁴

¹Departments of Obstetrics and Gynecology and ²Community Medicine, Parul Institute of Medical Sciences and Research, Parul University, Gujarat, ³Department of Community Medicine, NAMO MERI, Silvassa, ⁴Department of Community Medicine, C U Shah Medical College, Surendranagar, Gujarat, India

Abstract

Introduction: In older adults, excess weight is associated with a higher prevalence of cardiovascular disease, metabolic disease, several important cancers, and numerous other medical conditions. Several indices such as body mass index (BMI), waist circumference (WC), waist-to-hip ratio (WHR), and waist-to-height ratio (WHtR) are used to classify general. Some studies also reported that WC and WHR is a better indicator of cardiovascular disease (CVD) risk than BMI and WHR. Aims and Objective: 1. To estimate the prevalence of obesity among the elderly using three scale viz. BMI, WHR, and WHtR 2. To compare the results of these three-scale used for assessment of obesity 3. To determine the presence of association between obesity and hypertension if any. Material and Methods: For selection of the area, in both the urban and rural areas, the sampling units were enumerated and samples were collected from them. The estimated geriatric population combined in both Urban and Rural areas amounted to 12,220 (7% of geriatric population as per Census 2001), out of which 5% was selected as sample. This came out to be 611 elderly subjects which were selected equally from both urban and rural areas. For assessment of obesity BMI, WHR, and WHtR were measured. Assessment of hypertension was as per JNC classification. Result: Prevalence of obesity as per BMI in the urban area was found to be 40%, whereas that in rural areas was found to be 47.4%. WHR and WHtR showed higher prevalence in rural areas (70%) and also in urban areas (60%). BMI and WHR were significantly associated with hypertensive status of elderly. Conclusion: Anthropometric assessments of obesity like WHR and WHTR are more sensitive indicators of obesity among the elderly. BMI is found to be significantly associated with hypertension as well in the present study. Logistic regression showed that the association of BMI with hypertension was higher than other obesity assessments.

Keywords: Anthropometric assessment, anthropometry, BMI, hypertension, JNC Classification, obesity, waist height ratio, waist hip ratio

Introduction

Worldwide increase in longevity has shifted the age distribution towards elderly population.¹ In India, the size of the elderly population (above age of 60 years) is growing fast. As the data suggest that the absolute number in India increased from 76 million in 2001 to 100 million in 2011 and continues to rise further.²

Obesity is a worldwide problem with increasing prevalence and incidence in both developed and developing countries. In older adults, excess weight is associated with a higher prevalence of

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cardiovascular disease, metabolic disease, several important cancers, and numerous other medical conditions. Obesity among elderly is also an established risk factor for hypertension, hypercholesterolemia, insulin resistance, and diabetes. Obesity and hypertension are also a risk factor for cardiovascular disease, which creates significant economic burdens, especially in developing countries.

Anthropometry is the most basic method for assessing body composition. It is an easy, economical, and effective method that is used in the initial screening of obesity, hypertension, and other metabolic disorders. Several indices such as body mass index (BMI), waist circumference (WC), waist-to-hip ratio (WHR), and waist-to-height ratio (WHtR) are used to classify obesity. WHtR and WHR are better measures of visceral and abdominal fat distribution. On the other hand, some studies also reported that WC and WHR is a better indicator of cardiovascular disease (CVD) risk than BMI and WHR; however, a high WHR has been identified as an increasing risk factor of dyslipidemia, hypertension, CVD, and diabetes mellitus as compared with BMI. BMI is widely used to describe total or general obesity while WC, WHR, and WHtR describe more visceral fat; abdominal or centralised obesity.

Because human populations are leading to higher age and obesity, choosing the best measure to monitor the complications of obesity in the elder population is very important. The most common indicator used to measure obesity is the BMI. But this indicator does not indicate the distribution of central fat, while WHR is used as an alternative to determine the central distribution of obesity. Therefore, identification of risk factors associated with hypertension is required to determine the relationship between obesity and hypertension.

Among different anthropometric indicators, it has been seen that WC is the only clinical index of obesity associated with an increased ambulatory and conventional hypertension independent of other indices. However, WC does not account for differences in height, therefore, potentially over- and under-evaluating risk for tall and short individuals, respectively. Consequently, several researchers independently proposed the WHtR as an alternative to WC. This ratio has been shown to be a good indicator of abdominal adiposity, similar to WC and recent systematic reviews and meta-analyses have supported the use of WHtR as a better predictor of CVD risk factors.

So, BMI, WC, WHtR, and WHR are simple and valid anthropometric measures for the assessment of obesity and risk of hypertension. Screening of non-communicable diseases at regular intervals will help to diagnose them at an earlier stage and will prevent its long-term sequel. This study will be very helpful for the community and primary care physicians to orient them about the prevalence of obesity and the co-existence with hypertension and their determinants among the elderly population. Keeping all the above discussed factors in mind, it was decided to carry out this study and compare the different scales used for obesity with the classically used BMI and to associate the same with the hypertensive status of the study subjects.

### Aims and Objective

1. **To estimate the prevalence of obesity among the elderly using three scales viz. BMI, Waist hip ratio and Waist height ratio.**
2. **To compare the results of these three-scale used for assessment of obesity for both urban and rural study subjects.**
3. **To determine the presence of association between obesity and hypertension if any.**
Material and Methods

For selection of the area, in both the urban and rural areas, the sampling units were enumerated and samples were collected from them. For Rural data collection, out of all the 12 talukas in Surendranagar district, one taluka was selected by using simple random sampling, which came out to be Sayla taluka. For selection of villages, the similar process was followed and Sayla village was selected. For urban data collection, the city which has 14 wards were enumerated and by simple random technique, Ward No. 7 was selected for the study. The estimated geriatric population combined in both Urban and Rural areas amounted to 12,220 (7% of geriatric population as per Census 2001), out which 5% was selected as sample. This came out to be 611 elderly subjects which were selected equally from both urban and rural areas. Study was conducted for 6 months. The study was cross-sectional study by directly interviewing the subjects. Self-structured and pre-tested Performa was used, consisting of sociodemographic futures, current and past economical situation of elderly. The permission from ethical committee of C U Shah Medical College, Surendranagar was taken prior to the commencement of the study. Data was collected by directly interviewing and examining the subjects and was entered and analysed using MS excel 2007.

Hypertension is defined as systolic blood pressure of ≥140 mm of Hg and diastolic blood pressure of ≥90 mm of Hg using JNC 7 criteria. For measurement of blood pressure, a rest of

| Table 3a: Association of Obesity and Blood pressure among the elderly in Urban areas |
|-------------------------------|---------|---------|--------|--------|---------|-------------------|-----|
| **Obesity vs. Blood pressure** | Normal  | Pre‑hypertensive | Stage 1 | Stage 2 | Total   | Chi square | **P**  |
| **BMI Category**              |         |          |        |        |         |            |      |
| Underweight                   | 20      | 17       | 9      | 3      | 49      | 48.30      | <0.01|
| Normal Range                  | 25      | 57       | 33     | 19     | 134     |            |      |
| Overweight                    | 14      | 18       | 5      | 6      | 43      |            |      |
| Obese I                       | 15      | 14       | 11     | 9      | 49      |            |      |
| Obese II                      | 0       | 4        | 18     | 8      | 30      |            |      |
| Total                         | 74      | 110      | 76     | 45     | 305     |            |      |

| **Waist hip ratio category**  |         |          |        |        |         |            |      |
| Normal                        | 26      | 37       | 32     | 16     | 111     | 1.49       | 0.68 |
| Risk                          | 48      | 73       | 44     | 29     | 194     |            |      |
| Total                         | 74      | 110      | 76     | 45     | 305     |            |      |

| **Waist to height ratio category** |         |          |        |        |         |            |      |
| Underweight                   | 15      | 7        | 6      | 3      | 31      | 42.39      | <0.01|
| Normal                        | 21      | 39       | 17     | 13     | 90      |            |      |
| Overweight                    | 13      | 23       | 3      | 1      | 40      |            |      |
| Very Overweight               | 11      | 16       | 20     | 8      | 55      |            |      |
| Obese                         | 14      | 25       | 30     | 20     | 89      |            |      |
| Total                         | 74      | 110      | 76     | 45     | 305     |            |      |

| Table 3b: Association of obesity and Blood pressure among the elderly in Rural areas |
|-------------------------------|---------|---------|--------|--------|---------|-------------------|-----|
| **Obesity vs. Blood pressure** | Normal  | Pre‑hypertensive | Stage 1 | Stage 2 | Total   | Chi square | **P**  |
| **BMI Category**              |         |          |        |        |         |            |      |
| Underweight                   | 3       | 24       | 12     | 5      | 44      | 21.276     | 0.046|
| Normal Range                  | 6       | 44       | 30     | 37     | 117     |            |      |
| Overweight                    | 4       | 13       | 18     | 10     | 45      |            |      |
| Obese I                       | 8       | 30       | 16     | 34     | 88      |            |      |
| Obese II                      | 0       | 6        | 3      | 3      | 12      |            |      |
| Total                         | 21      | 117      | 79     | 89     | 306     |            |      |

| **Waist hip ratio category**  |         |          |        |        |         |            |      |
| Normal                        | 6       | 27       | 28     | 28     | 89      | 3.84       | 0.27 |
| Risk                          | 15      | 90       | 51     | 61     | 217     |            |      |
| Total                         | 21      | 117      | 79     | 89     | 306     |            |      |

| **Waist to height ratio category** |         |          |        |        |         |            |      |
| Underweight                   | 0       | 3        | 0      | 3      | 6       | 29.69      | 0.003|
| Normal                        | 7       | 21       | 25     | 16     | 69      |            |      |
| Overweight                    | 2       | 43       | 22     | 17     | 84      |            |      |
| Very Overweight               | 4       | 29       | 13     | 17     | 63      |            |      |
| Obese                         | 8       | 21       | 19     | 36     | 84      |            |      |
| Total                         | 21      | 117      | 79     | 89     | 306     |            |      |
10 min. was given to all study subjects prior to the measurement in sitting position. The measurement was done by using standard mercury sphygmomanometer and standard stethoscope after calibration with already calibrated instruments. A total of three measurements were taken for the systolic and diastolic blood pressure on the study subjects. Out of the three, an average was taken for the final classification. The higher classification for either of the systolic or diastolic was taken as the final BP classification of the study subjects. All subjects currently on anti-hypertensive medication or having a prescription of anti-hypertensive drugs were classified as hypertensive as per their current blood pressure range.

For the assessment of obesity, anthropometric measurements were taken by a trained staff, according to the World Health Organization (WHO) recommendations as depicted in Table 1.22 For measurement, weight machine was used after calibration. Weight was measured to the nearest 0.5 kg, height was measured with the subject barefoot in the standing position to the nearest 0.5 cm. BMI was calculated by dividing weight per kilograms by height per meter square (kg/m^2). The waist circumference and hip circumference was measured using stiff and non-elastic measuring tape. WC was measured to the nearest centimetre, midway between lowest rib margin and iliac

### Table 4: Comparison of newer scales used for obesity with BMI

| Waist hip ratio category (Urban) | BMI Category | Total | Chi square value | P  |
|---------------------------------|--------------|-------|-----------------|----|
| Underweight                     | Normal       | 28    | 53              | 12 | 12 | 111 | 22.21 | <0.01 |
| Risk                            | 21           | 81    | 37              | 37 | 18 | 194 | 305   |
| Total                           | 49           | 134   | 43              | 49 | 30 | 305 | 305   |

### Table 5: Comparison of the newer scales used for obesity

| WHP Ratio | WHT Ratio (Urban) | WHT Ratio (Rural) |
|-----------|-------------------|-------------------|
| Normal    | 68                | 43                | 43                | 32 |
| Risk      | 53                | 41                | 46                | 185|
| Chi square value | 0.8438 | | 2.1667 | |
| P         | 0.35              |                  | 0.1410            |

### Table 6: Effect of different scales on hypertension using binary logistic regression

| Three obesity variables vs Hypertension | Hypertension Urban | Hypertension Rural | P  |
|----------------------------------------|-------------------|-------------------|----|
| BMI                                    | 1.528             | 1.255-1.861       | <0.01 | 1.13 | 0.927-1.377 | 0.227 |
| Waist Hip Ratio                        | 1.263             | 0.786-2.03        | 0.335 | 0.629 | 0.379-1.04 | 0.072 |
| Waist Height Ratio                     | 1.409             | 1.187-1.672       | <0.01 | 1.108 | 0.914-1.34 | 0.296 |
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To compare the results with newer scales, prevalence was also measured in terms of WHR in urban areas which was 63.6% and that in rural areas was 70.9%, similarly as for WHtR the prevalence in 60.3% in urban areas and 75.6% in rural areas. The prevalence was higher in the rural areas as per all the three scales as compared to that in the urban areas.

As seen in Figure 1, it can be seen that in the urban areas, nearly 40% were hypertensive, whereas in rural areas, more than half, that is, 55% were hypertensive. The prevalence of pre-hypertension was 38% in rural areas and almost the same, that is, 36% in urban areas. Higher prevalence thus found in rural areas as compared to urban areas.

As shown in Table 3a, it can be seen that in urban areas, the BMI and WHR were both found to be statistically significant in their association with the hypertensive status, whereas the WHR was not found significantly associated.

As shown in Table 3b, it can be seen that in rural areas also a similar picture was seen in that BMI and WHR were both found to be statistically significant in their association with the hypertensive status, whereas the WHR was not found significantly associated.

As shown in Table 4, it shows a significant association between the newer two scales when compared with BMI. Both WHR and WHtR have shown a significant association with BMI which is commonly used scale except in rural areas where WHR is not significantly associated.

As shown in Table 5, the Mc Nemar’s Chi-square was applied to find out a significant difference between the results of the two newer scales. It was seen that there was no such statistically significant difference found. This reflects the fact that the scales showed similar results of “normal” and “at risk” or “obese/overweight” status of the study subjects.

As shown in Table 6, binary logistic regression was applied to find out the strength of association for the outcome of hypertension to know which scale of obesity helps to best predict the outcome. It can be seen that the scales in the present study have shown near similar results. Even though some have statistically significant results and some don’t, the results are quite similar for the association for hypertension. From the existing data, BMI seems to be a better predictor of Hypertension as compared to the other two newer scales, that is, Waist to hip and Waist to height ratios.

**Discussion**

The present study enrolled 611 elders. Females constituted 56.3% of the study population. Around 28% in urban and 58% in rural were illiterate. Most of the subjects were married and about 30% in both areas, who were widow/widower.

Modified Prasad’s Classification (2009) was used to calculate the social class of the families in both urban and rural areas. Majority of the families in the urban areas were from social class 4 (29%), followed by those from social class 3 (24%), whereas in the rural areas, majority of the families were from social class 5 (47%) followed by those from social class 4 (26%).

As shown in Table 2, prevalence of obesity as per BMI in the urban area was found to be 40%, whereas that in rural areas was found to be 47.4%. This shows a high level of prevalence among the elderly as per the most commonly used scale BMI. To compare the results with newer scales, prevalence was also measured in terms of WHR in urban areas which was 63.6% and that in rural areas was 70.9%, similarly as for WHtR the prevalence in 60.3% in urban areas and 75.6% in rural areas. The prevalence was higher in the rural areas as per all the three scales as compared to that in the urban areas.

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**Results**

Assessment of sociodemographic profile of study subjects showed that majority of the subjects in the urban area were in the age group up to 75 years, whereas in the rural area most of the subject aged more than 65 years. In the urban area, majority of subject were females, whereas in rural area proportions were same. About 99% of the subjects in urban areas and about 89% of rural subjects were Hindus. Nearly 60% of the subjects in both urban and rural area were currently unemployed. About 58% of the subjects in the urban and rural area were unemployed. Majority of the subject in urban area were professional or semiprofessional where those in rural area were skilled or unskilled workers. With respect to education, 28% in urban and 58% rural were illiterate. Majority of the literate in both the areas were educated up to primary. About 14% in urban, 4% in rural were graduates. Most of the subjects were married and about 30% in both areas, who were widow/widower.

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The present study revealed 47.4% prevalence of obesity (as per BMI) in the rural area. This is much higher than study by Gupta R et al[28] and Mungreiphy NK,[33] which reported 9% and 2%, respectively. The National Family Health Survey-5 (NFHS-5) reported 56% prevalence of obesity in the urban area and 32.6% in the rural area for Gujarat.[34]

The present study reported 63.6% prevalence of obesity in urban areas and 70.9% in rural areas was as per WHR (abdominal obesity). Bhardwaj S et al.[37] reported 68.9% prevalence of abdominal obesity. The finding of this study is correlating with the fact that Asian Indians have a greater predisposition to abdominal obesity termed as “Asian Indian phenotype.”[35,36]

The present study reported high burden of hypertension in the elderly age group (39.7% in urban areas and 54.9% in rural areas). Earlier studies have found the prevalence of hypertension among geriatric population of Puducherry,[37] Surat,[38] Uttarakhand,[39] Maharashtra,[40] Kerala,[41] and Kolkata[42] to be 40.5%, 52.0%, 40.94%, 36.1%, 34.6%, and 64%, respectively. The study showed significant association between obesity (as per BMI and WHR) and hypertension in both urban and rural areas. Obesity has been found to be an important predictor of hypertension by other studies also.[43‑46]

The study also showed that WHR and WHtR have significant association with BMI. Similar finding was also noted by Kokiwar et al.[47] and Midha et al.[48] From the study it was revealed that WHtR can be a proxy measure for BMI to assess the obesity. This is consistent with the findings of Lucy M. Browning et al.[47] and Lam BCC et al.[49]

While some studies report that the risk of developing hypertension was greater with increased BMI, compared to WC,[50] others suggest that visceral adiposity is generally a stronger predictor of hypertension than BMI-based measures.[51] Visceral adiposity is not only a predictor of hypertension, but also correlates with the severity of the disease. In this study, WC rather than BMI increased the severity of hypertension. This finding is consistent with study done on Mexican American population.[52] Greater central obesity can be associated with systemic inflammation which directly contributes to CVD risk.[53] The WHtR was described as a useful tool for assessing abdominal adiposity.[54] Like other studies, the study found that WHtR is superior to WC and BMI in association with hypertension[55,56] in the male group. In a meta-analysis done, WHtR was found to be significantly better than WC for hypertension, CVD, and all outcomes in both men and women.[51]

Binary logistic regression showed that in the urban area waist height ratio and BMI were significantly associated with hypertensive status, whereas in the rural area BMI showed significant relationship. These findings were similar to study carried out by Midha et al.,[49] Kokiwar et al.,[47] and Panda et al.[55] in their respective study area.

**Conclusion**

It can be concluded from the study that the prevalence of obesity among the elderly is quite high as detected in different scales. Anthropometric assessments of obesity like WHR and WHtR are more sensitive indicators of obesity as compared to BMI among the elderly. This is due to a higher reported prevalence through them. BMI is found to be significantly associated with hypertension as well in the present study. Logistic regression showed that the association of BMI with hypertension was higher than other obesity assessments. This re-iterates the fact that BMI is also an equally important indicator of obesity and should be used to determine the prevalence as it can be used easily during screening procedures. WHR and WHtR on other hand are important to determine cardiovascular risk like hypertension and other cardiovascular disorders among elderly. Studies of similar types need to be conducted to identify inter-relationships between these indices and develop an evidence of the best scale for assessment of obesity among the elderly.

The concepts that emerge from this study include the use of newer scales like WHR and WHtR in hospital and/or community settings by primary care physicians. The role of determining cardiovascular risk and risk of hypertension with newer scales is profound and needs to be used as a screening tool. BMI, a widely used scale, is also important but rarely differentiates between fat mass and muscle mass and hence cannot determine the cardiovascular risk that accurately. The prevalence of pre-hypertension among the elderly was also quite significant up to nearly 36–38%. The prevalence of stage 1 and stage 2 hypertension in rural and urban areas was quite high as compared to previous documented studies. The association between hypertension and obesity was found statistically significant.

**Recommendations**

It can be recommended from the study that BMI can be continued to be used to screen the elderly for obesity and the WHR and/or WHtR can be used to estimate the central obesity and the cardiovascular risk resulting thereafter. The higher prevalence of hypertension among elderly also needs due attention of policy managers. The prevalence of obesity among the elderly is surely a cause of concern and hence screening and life-style modifications need to be carried out at regular intervals starting from the youngest of the elderly age group. Physical exercise and involvement in physical activities should be encouraged and systems need to be more sensitive in this approach. Screening of Non-communicable diseases needs to be carried out at regular intervals for the elderly population and prompt referral is the need of the hour. Geriatric clinics need to be operational at all centres including primary health centres to deal with the increasing need of elderly healthcare which is well re-iterated in Ayushman Bharat also.
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Conflicts of interest
There are no conflicts of interest.

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