STUDY OF ANTHROPOMETRIC PATTERNS OF SELECTED INDICATORS IN ADULTS OF LOW INCOME RESIDING IN RURAL AREA AND THEIR ASSOCIATION WITH CVD RISK FACTORS

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ABSTRACT

BACKGROUND

Anthropometry is used to assess health of individuals and communities. It is a tool that provides rapid and quantitative assessment of nutritional and clinical states in children, adults or other population groups. Height, weight, waist and hip circumferences in adults, Midarm Circumference (MAC) head and chest circumferences are common anthropometric measurements in children. Body Mass Index (BMI), Waist-To-Hip Ratio (WHR) and Waist-To-Height Ratio (WHtR) commonly used indices to identify adults for intervention and follow up. Anthropometry is a simple, noninvasive and inexpensive method used in community or clinic settings for screening for underlying disease or risk factors. Bihar state has a high population of rural poor. It was decided to study anthropometric patterns of low-income villagers and their vulnerability to CVD risk factors, which are generally associated with affluence and urbanisation.

MATERIALS AND METHODS

Cross-sectional community-based study conducted on low-income adults aged thirty years and above residing in the villages of Phulwari Sharif Block of Patna district. Sociodemographic details followed by anthropometry, blood pressure and fasting blood sugar measurements of 1529 participants done.

RESULTS

Maximum number of participants were labourers (24.78%) followed by farmers (19.81%) of age group 30-39 years (38.26%). BMI was within normal range (18.5-23) for 34.33% males and 34.69% females. Only 10.09% males and 1.80% females were overweight or obese; more than half (55.58% males, 63.51% females) were underweight. WC was normal for 96.3% of males and 68.1% of females. WHR was abnormal in 15.4% males and 70% females; WHtR was abnormal in 14% males and 72% females. 5.82% were hypertensive; 9.55% was hyperglycaemic, WHR for both males and females was significantly associated with hypertension (P value = 0.000 in both sexes). WHtR of both males and females also found to be significantly associated with and with high BMI (P = 0.001); hypertension (P-value 0.004 and 0.000, respectively). Both WHR and WHtR in females were significantly associated to hyperglycaemia (FBG >126 mg/dL) in females only.

CONCLUSION

Anthropometric patterns of this low-income rural population reveals the existence of underweight implying chronic energy deficiency. However, there is also prevalence of truncal obesity especially in females, which is also significantly associated with CVD risk factors of hypertension in both sexes and hyperglycaemia in females. CVD risk factors can coexist with chronic energy deficiency in non-affluent societies and anthropometry can be used to screen such persons for intervention.

KEYWORDS

Anthropometry, Affluence, Rural, Low-Income, CVD Risk Factors, Underweight.

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BACKGROUND

Anthropometric measurements help in the evaluation of health in children, adults and special population groups. Nutritional anthropometry is based on the fact that physical state and gross composition of body are influenced by diet and nutrition especially in the rapidly growing period of early childhood, adolescence and during periods in which there is vulnerability to malnutrition (pregnancy, lactation and chronic diseases).[1] In adults, they serve as indicators of underlying disease including cardiovascular risk factors.

Anthropometry provides rapid and quantitative means of nutritional and clinical assessment, which is accurate, reliable and useful in monitoring normal growth, clinical health and nutrition. Given the sensitivity and specificity of an anthropometric measurement, it is a useful tool that can be easily used for community evaluation purposes.[2] Anthropometry is simple, inexpensive, noninvasive tool for screening of individuals or population groups, predicting persons who would benefit from interventions, evaluating

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responses to interventions and identifying social and economic inequity. Anthropometric obesity indicators are used both in community and clinic settings to identify individuals at risk for cardiovascular disease. Uses and interpretations of different anthropometric indicators will help to identify groups for intervention and program evaluation.[3]

Studies on patterns of anthropometric measurements and their role in identifying morbidity and risk factors for potential disease have been carried out previously. However, no such study had been undertaken in Bihar, which is predominantly a poor agricultural state with 88.70% rural population.[4] It was decided to study the anthropometric patterns of adults in a low-income rural population conventionally not having CVD risk factors.

Aims and Objectives

1. To find out the patterns of anthropometric indicators in adults above 30 years of low-income group living in rural area.
2. To compare the anthropometric patterns of the study population with anthropometric patterns of other populations.
3. To study the association of anthropometric indicators of this population with cardiovascular risk factors.

MATERIALS AND METHODS

This community-based cross-sectional study was conducted in the villages of Phulwari Sharif Block, the rural field practice area of Department of Community Medicine, Patna Medical College.

Study Units

Adults of both sexes residing in the villages of Phulwari Sharif block. Above 30 population taken as they did not have any known risk to CVDs. Most residents of these villages had per capita income below 3000/- month. However, to ensure homogeneity and eliminate confounding due to higher income/affluence, adults with per capita income above 3000/- month were excluded from the study.

Inclusion Criteria

- All consenting adults aged 30 years and above.
- Per capita income below Rs. 3000/- month.

Exclusion Criteria

- Children and adults below 30 yrs.
- Very sick.
- Income above Rs. 3000/- month.
- Non-consenting.

Study Period

One year from January 2012 to December 2012.

Sampling Method

The selected block Phulwari Sharif was divided into 4 quadrants. Four villages in each quadrant were randomly chosen giving a total of 16 villages in the block.

Population of Phulwari Sharif block was 2,72,078.[4] Taking the rural population to be 88.70%[4] and target population (adults above 30 yrs. of age) being 41.46%,[5] sample size of 1461 at 99.99% CL was calculated using StatCalc, Epi-Info 7. Hence, in each village, it was decided to recruit 100 adults to get sample of 1600. Team from Patna Medical College visited each selected village and enrolled 100 adults according to inclusion criteria. After recording sociodemographic details such as age, sex, occupation, education and income, the participants were invited to a health camp organised by the Department of Community Medicine on prefixed date to avail the services of health checkup by team of doctors and technicians. Physical examination of the study subjects, height, weight, waist and hip circumferences were measured and recorded. Blood pressure of all study subjects was measured according to the standard procedure. Biochemical tests were performed including fasting blood glucose. The variables to be studied in each subject were entered into pretested proforma. This process was conducted consecutively in all the 16 villages as per pre-decided list and schedule. Data on all variables to be studied could be obtained from 1529 participants only, 71 participants did not turn up at the health camp.

Data Collection and Tools

Proforma in questionnaire form was developed, pretested for recording the variables to be studied. Preceding the study, approval from Institutional Ethics Committee of Patna Medical College and informed consent from subjects obtained.

The height, weight, waist and hip circumference were measured by the investigator himself to avoid possible observer bias. BMI, Waist-To-Hip Ratio (WHR) and Waist-To-Height Ratio (WHtR) were calculated.

Height was measured to the nearest cm using portable height measuring stand; weights were measured by standard bathroom scales. BMI was calculated as kg/m2; BMI ≥25 in both males and females is generally taken as cut-off.[6,7] However, WHO recommendation for Asians including Indians, the cut-off 23 kg/m2 for public health action was considered. The categories suggested for Asians less than 18.5 kg/m2 (underweight); 18.5-23 kg/m2 (normal); 23-27.5 kg/m2 (overweight) and 27.5 kg/m2 or higher (obesity)[8] was used to classify BMI.

A flexible, non-stretchable measuring tape (tailors tape) having marking from 1-150 cm was used for measuring the waist and hip circumferences in standing position. WC measured midway between lower border of rib cage and iliac crest; HC at the widest part of buttocks. Waist circumference >90 cm in males and 80 cm in females was taken as cut-off for risk factor in development of metabolic syndrome.[9] Waist-To-Hip Ratio (WHR) calculated as WC in cm/HC cm, if above 0.90 in males and 0.85 for females considered abnormal.[9] Waist-To-Height Ratio (WHtR) was calculated by WC in cm/height in cm; cut-offs for WHtR were ≥0.48 in males and ≥0.45 in females.[10]

Blood pressure measured by mercury sphygmomanometer (diamond). As per JNC 7 criteria, it was considered positive if Systolic Blood Pressure (SBP) >140 mmHg and Diastolic Blood Pressure (DBP) >90 mmHg or if the subjects had a previous diagnosis of hypertension. For measurement of Blood Pressure (BP), an average of three readings measured thrice at the interval of fifteen minutes after resting was taken. Fasting Blood Glucose (FBG) sampling was done by venous sampling on overnight fasting about which prior information was given. The test considered positive if FBG ≥126 mg/dL.

Statistical Analysis

The data so collected were entered into Microsoft Excel Worksheet 2007 analysed using appropriate test.

Anthropometric measurements used to calculate obesity indices of BMI, WHR and WHtR. All subjects who had screened positive with hypertension, hyperglycaemia and/or diabetes were further analysed for their association with the other risk factors using Epi-Info 7 and STATA. Variables were tested for their significance by two-tailed Chi-square test (x^2), Degree of Freedom (DF) and Probability (p) values were derived from tables. Data was analysed by using Epi-Info 7 and STATA. Percentages and proportion of the population having CVD risk factors was calculated.

RESULTS

Maximum number of participants were from age group 30-39 years (38.26%). Enrolment decreased as age increased with only 4.31% above 70 years. Maximum number of participants were labourers (24.78% males and 18.83% females) followed by farmers (19.81% males and 15.04% females). Majority (73.9%) were illiterate (12.62% of males; 61.28% of females). Monthly income of 618 participants (40.49%) was ≤ Rs. 1,500/- only; 911 (59.51%) had had monthly income of ≥Rs. 1,500/- only (Table 1). Sample t-test with the general population was significant for age and income indicating that these variables were unique to the study population.

Age (n=1529)				
Age Group	**Male No. (%)**	**Female No. (%)**	**Total No. (%)**	**Significance**
30-39 yrs.	100 (17.10%)	485 (82.90%)	585 (38.26%)	T = 43.45; P = 0.00
40-49 yrs.	37 (11.22%)	293 (88.78%)	330 (21.60%)	
50-59 yrs.	76 (26.03%)	216 (73.97%)	292 (19.09%)	
60-69 yrs.	118 (46.10%)	138 (53.90%)	256 (16.74%)	
≥70 yrs.	36 (54.55%)	30 (45.45%)	66 (4.31%)	
Occupation (n=1529)				
Housewife	0	691 (100%)	691 (45.19%)	
Labourer	91 (5.95%)	288 (18.83%)	379 (24.78%)	
Agriculture	73 (4.77%)	230 (15.04%)	303 (19.81%)	
Unable to work	15 (0.98%)	49 (3.20%)	64 (4.18%)	
Govt.	3 (0.2%)	11 (0.72%)	14 (0.92%)	
Self	9 (0.59%)	29 (1.90%)	38 (2.49%)	
Unemployed	6 (0.39%)	17 (1.11%)	23 (1.50%)	
Non-Govt.	4 (0.26%)	13 (0.85%)	17 (1.11%)	
Education (n=1529)				
Illiterate	193 (12.62%)	937 (61.28%)	1130 (73.9%)	
Primary	24 (1.57%)	63 (4.12%)	87 (5.70%)	
Middle	55 (3.60%)	93 (6.08%)	148 (9.68%)	
Secondary	56 (3.66%)	45 (2.94%)	101 (6.60%)	
Intermediate	16 (1.05%)	19 (1.24%)	35 (2.30%)	
Graduate	23 (1.50%)	4 (0.26%)	27 (1.76%)	
PG	0	1 (0.06%)	1 (0.06%)	
Administration	0	0	0	
Technical/Eng.	0	0	0	
Income (n=1529)				
<1500/-	150 (9.81%)	468 (30.61%)	618 (40.49%)	T = -5.49; P = 0.00
>=1500/-	217 (14.12%)	694 (45.39%)	911 (59.51%)	

Table 1. Sociodemographic Details of Study Population (n=1529)

Anthropometric Indicators	**Normal N (%)**	**Abnormal N (%)**	
		<18.5 (%)	**>23 (%)**
BMI (M)	126 (34.33%)	204 (55.58%)	37 (10.09)
30-39	37 (10.08%)	52 (14.16%)	12 (12)
40-49	17 (4.63%)	22 (6.0%)	5 (11.3)
50-59	27 (7.35%)	37 (10.08%)	7 (9.8)
60-69	30 (8.17%)	61 (16.62%)	11 (10.8)
>=70	15 (4.08)	32 (8.71%)	2 (4.1)
BMI (F)	403 (34.69%)	738 (63.51%)	21 (1.80)
30-39	180 (15.50%)	393 (33.82%)	9 (1.5)

40-49	95 (8.17%)	150 (13.0%)	7 (2.7)
50-59	68 (5.85%)	97 (8.34%)	4 (2.4)
60-69	47 (4.04%)	73 (6.28%)	1 (0.8)
>=70	13 (1.11%)	25 (2.15%)	0 (0)
WC (M)	1473 (96.3%)	56 (3.7%)	
WC (F)	1042 (68.1%)	487 (31.9%)	
HC (M)	367 (24%)	0 (0.00%)	
HC (F)	1162 (76%)	0 (0.00%)	
WHR male	1278 (83.6%)	251 (16.4%)	
WHR female	459 (30%)	1070 (70%)	
WHtR male	1315 (86%)	214 (14%)	
WHtR female	415 (27.1%)	114 (72.9%)	

Table 2. Distribution of Frequencies of Anthropometric Indicators (n=1529)

M-Male, F-Female, BMI-Body mass index, WC-Waist circumference, HC-Hip Circumference, WHR-Waist-To-Hip Ratio, WHtR-Waist-To-Height ratio.

Table 2 shows the distribution patterns of anthropometric indicators in the study population. BMI was within normal range (18.5-23) for 34.33% males and 34.69% females. Only 10.09% males and 1.80% females were overweight or obese; more than half (55.58%) were underweight. The majority had BMI either <18.5 or between 18.5-22.9 (96.19%). WC was normal for 96.3% of males and 68.1% of females. HC was within normal limits of cut-offs for both males and females. WHR was normal in 83.6% males and 30% females; abnormal in 15.4% males and 70% females. WHtR was normal in 86% of males and 27.1% of females and abnormal in 14% males and 72% females.

	Hypertensive No. (%)	**Mean Systolic BP (SD)**	**Mean Diastolic BP (SD)**	**Hyperglycaemic No. (%)**	**Mean Fasting Blood Glucose (SD)**
Total population (1529)	89 (5.82)	122 (13.47)	79.52 (6.81)	146 (9.55)	71.32 (50.10)
Male (367)	58 (15.8)	125.86 (14.72)	80.74 (7.24)	85 (7.31)	85.97 (45.31)
Female (1162)	31 (8.45)	121.42 (12.88)	79.13 (6.62)	61 (5.25)	66.69 (50.66)

Table 3. Distribution of CVD Risk Factors (HTN and FBG) in Study Population

Table 3 shows that only 5.82% of total population was hypertensive with a mean systolic blood pressure 122 mmHg and mean diastolic systolic blood pressure 79.52 mmHg. Of the total population, only 9.55% was hyperglycaemic with a mean FBS of 71.32 mg/dL. The values are comparable for both genders. This implies that the majority of study population consisted of normotensive and normoglycaemic individuals.

	Association Between Anthropometric Indicators and Hypertension		**Association Between Anthropometric Indicators and Fasting Blood Glucose**	
Anthropometric indicators	r^2	P-value	r^2	P-value
High BMI	11.713	0.001	0.231	0.631
High WC male	2.690	0.101	0.130	0.718
High WC female	0.598	0.439	0.388	0.534
WHR male	16.246	0.000	2.022	0.155
WHR female	24.206	0.000	5.934	0.015
WHtR male	8.188	0.004	1.634	0.201
WHtR female	26.383	0.000	5.883	0.015

Table 4. Association Between Anthropometric Indicators and Hypertension and Fasting Blood Glucose (n=1529)

Association between anthropometric indicators and cardiovascular risk factors of hypertension and Fasting Blood Glucose (FBG) could also be seen (Table 4). WHR for both males and females was significantly associated with hypertension (P value = 0.000 in both sexes). WHtR of both males and females also found to be significantly associated with hypertension (P-value 0.004 and 0.000, respectively) and with high BMI (P = 0.001). Both WHR and WHtR were significantly associated to hyperglycaemia (FBG >126 mg/dL) in females only. This implies that truncal obesity as elicited by the anthropometric measurements in this study could also be a risk factor for elevated fasting blood glucose levels. The preponderance of female subjects in this study could be the reason for it showing up only in this segment of study population. More studies with larger number of participants and equal distribution of sexes needed to validate this finding.

DISCUSSION

The present community-based cross-sectional study was carried out in a low-income rural community spread over 16 villages of Phulwari Sharif Block of Patna district comprising mainly of labourers and farmers. No studies have been done on this segment of population to know their vulnerability to cardiovascular diseases. Among the 1600 subjects initially enrolled, only 1529 subjects underwent anthropometry, blood pressure measurements and overnight FBG test. Rest 71 did not turn up in spite of three successive visits.

Anthropometric patterns of this population showed that a third of population (34.33% males and 34.69% females) had BMI within normal range of 18.5-23. More than half (55.58% males and 63.51% females) had BMI <18.5. Only, 10.9% males and 1.80% females had BMI >23. In this population, underweight and chronic energy deficiency appears to be more a cause for concern for public health action than overweight.

In the U.S. National Health and Nutrition Examination Surveys of 1994, 2007 and 2008 on body mass indices, it was seen that 59% of American men and 49% of women had BMIs over 25. Morbid obesity that is BMI of 40 or more was found in 2% of the men and 4% of the women. In the survey of 2007, a continuation of increase in BMI was seen. Sixty three percent of Americans were overweight or obese with 26% in the obese category (BMI of 30 or more). In the 3rd survey in 2008, Romero-Corral et al examined 13,601 subjects from the United States and found that BMI-defined obesity was present in 21% of men and 31% of women.[11]

The BMI cut-off values for dietary intervention in men and women in a study conducted in adult Indian population was 23 kg/m^2. These values were significantly lower than the corresponding values in white populations.[12] A similar study conducted in urban slums of Patna identified need for preventive action due to prevalence of high BMI (31.94%).[13]

However, this study shows low prevalence of obesity, which may be due to fact that it was conducted in a rural low income population, a unique group not studied earlier. WHtR was above the cut-offs in 14% males and 72.9% of females. Chamukattan Snehlata et al have reported that despite having lean BMI Indians have increased upper body obesity, which increases the risk of insulin intolerance, diabetes and CVD risk factors. Although, BMI is the most frequently used index. It does not reflect obesity uniformly in all populations.[14] Similar anthropometric patterns were seen in this study.

However, high BMI was significantly associated with HTN in both sexes (P=0.001). WHR males and females were significantly associated with HTN (p-0.000). WHtR in males and females was also significantly associated with HTN (P=0.004 and 0.000). This shows that anthropometry measurement can be used to screen HTN, which is important CVD risk factor.

The mean systolic blood pressures were 125.86 and 121.42 mmHg while the mean diastolic blood pressures were 80.74 and 79.13 mmHg in men and women respectively. In a study by Singh et al on hypertension in rural Bihar, the prevalence of hypertension is found to be 23.73%. Mean SBP and DBP 144.8 and 89.0, respectively. However, in this study, the age cluster was higher (50-59 yrs.) with a significant male preponderance.[15]

BMI and WC had strong correlation with systolic and diastolic blood pressure. The suggested lower cut-off values of the anthropometric indicators will cover maximum of the population with higher odds of having hypertension and may help in reducing the mean population blood pressure levels.[16]

Hypertension was found to be positively associated with body and abdominal fat anthropometric indicators with BMI being the indicator with higher statistical power in both genders, although it was found to be similar to the other indicators in women. Except for WHtR, the other indicators were positive and independently associated with hypertension in both genders. The results obtained show the relevance of these indicators in identifying hypertension risk and the importance of adopting them in clinical practice/epidemiological studies for general and special population groups. Use of these anthropometric indicators whose cost practicality and reliability are advantageous can contribute to early identification of hypertension risk, enabling prevention and management actions and strategies.[17]

Indicators of truncal obesity in females (WHR and WHtR) was significantly associated with FBS, but not any other indicator. Similar findings were found in rural Andhra Pradesh by Chow C et al.[18] However, more studies required to validate these observations.

The strength of this study is that it focused on a relatively deprived section of the population and revealed under nutrition as well as CVD risk factors. A review of 144 published studies of the relationship between Socioeconomic Status (SES) and obesity reveals a strong inverse relationship among women in developed societies. The relationship is inconsistent for men and children in developed societies. In developing societies, however, a strong direct relationship exists between SES and obesity among men, women and children. A review of social attitudes toward obesity and thinness reveals values congruent with the distribution of obesity by SES in different societies. Several variables may mediate the influence of attitudes toward obesity and thinness among women in developed societies that result in the inverse relationship between SES and obesity. They include dietary restraint, physical activity, social mobility and inheritance.[19]

Valuable anthropometric data was obtained in this study from a rural population having frugal income and lifestyles far removed from affluence. While revealing chronic energy deficiency, it also demonstrated risk of developing hypertension, an important CVD risk factor considered bane of affluent. The findings warrant intervention to improve the quality of diet of the underprivileged to improve their health and reduce vulnerability to CVDs. Creating awareness about prudent diets within their economic means is a necessity.

CONCLUSION

The study of anthropometric patterns in adults of this low-income rural population reveals the existence of underweight implying chronic energy deficiency. However, there is also prevalence of truncal obesity, especially in females, which is also significantly associated with CVD risk factors of hypertension in both sexes and hyperglycaemia in females. This implies that CVD and risk factors are no longer diseases of affluence and can coexist with underweight and possible chronic energy deficiency. There is need to include them into preventive care and intervention. The possibility of increasing cardiovascular risk factors and prevalence of vascular disease in areas of rural India are of concern. Anthropometry is a useful tool that can be used to identify those for intervention.

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