O R I G I N A L   A R T I C L E

A study on levels of body mass index and waist-hip ratio among adult women in a tertiary care health facility

Priyadharsini Rajendran[1], Raja TAR[2], Prakash Manivel[3], Dhananjay Yadav[4]

[1]Assistant Professor, Department of Pharmacology, Indira Gandhi Medical College and Research Institute (IGMC&RI), Puducherry 605 009, India; [2]Associate Professor, Department of Pharmacology, Melmaruvathur Adhiparasakthi Institute of Medical Sciences, (MAPIMS), affiliated to MGR University, Tamil Nadu 603319, India; [3]Assistant Professor, Department of Community Medicine, Indira Gandhi Medical College and Research Institute (IGMC&RI), Puducherry 605 009, India; [4]Research Professor, Department of Medical Biotechnology, Yeungnam University Gyeongsan-Si, Gyeongbuk, Republic of Korea (712-749)-E-mail: dhanyadav16481@gmail.com

Summary. *Background and Aim:* This study aimed to assess the nutritional status of adult literate women belonging to the upper socio-economic groups by using the body mass index (BMI) and waist-to-hip ratio as indicators. An attempt to find out the different factors and pattern of some disease conditions influencing these scenarios has also been done. *Methodology:* A descriptive cross-sectional study was undertaken with 150 Undergraduate (UG)/Postgraduate (PG) residents studying various courses in medicine, along with 150 nurses and 150 women residing in various residential quarters of Dhanvantari campus in Puducherry. Prior to the study, a written consent was obtained from all participants with measurement of their height, weight, waist and hip circumference. *Results:* The proportion of standard weight, overweight and obese were 33.3%, 42.1%, and 24.6 % respectively. Undernutrition was present in 2.5% of the study subjects. It was found that about one-third of the subjects had normal BMI, however, the rest were either overweight or obese. The factors influencing BMI groups were age, occupation, physical activity and the number of children. Diabetes and hypertension were associated with overweight and obesity. Waist-to-hip ratio showed that about 75% of study subjects had higher (>0.8) values. *Conclusion:* Even though healthy lifestyle is a major concern today, overweight/obesity has to become an increasing burden among adult literate women. Hence, appropriate measures to monitor the trend of body weight towards overweight/obesity among women should be undertaken on a routine basis.

Key words: Body Mass Index, waist-hip ratio, graduates, housewives, nurses, adults

Introduction

Obesity is a rapidly emerging concern in most of the countries today. There is also a dual burden of overnutrition and under-nutrition in these countries (1). The prevalence of overweight and obesity has increased slightly over the past decade in India, and it has reached a relatively high level in the urban and high socioeconomic groups (2). Several indicators were used to assess the nutritional status among adults. Body Mass Index (BMI) is one among them, though the other indicators

such as waist-hip ratio, body weight, and arm circumference had been used. BMI and waist-hip ratio have attracted the attention of researchers, as they are age independent and easy to measure (3). Further, waist-to-hip ratio and waist circumference have the strongest associations with risk of Ischemic heart disease (IHD) (4). The World Health Organization (WHO) has set out the standards in 1995 and has given the cut-off values for BMI. A value of equivalent or less than 18.5 is considered as thinness or undernourished; between 18.5 and 24.9 as normal and 25-29.5 as overweight and

above 30 as obese (5). However, in developing countries these cut-off points may not reflect a true picture. Cut-off values at lower levels were being tried (6). It has been found that Indian women show a positive trend towards a higher BMI range (7). According to the cross-sectional analyses of the 2005-2006 Indian Demographic Health Survey (IDHS), the overall prevalence of overweight was 12.4%, 3.2% for obesity, and 26.5% for underweight. Obesity was nearly thrice more likely in the urban areas than in the rural and women were 2.71 times more likely to be obese than men. Better socioeconomic status was significantly associated with overweight and obesity (8). A study from Pakistan showed that BMI was positively associated with income (9). It has also been found that the prevalence of overweight in young women of both urban and rural areas are higher in developing countries (10). Thus, this study was aimed to assess the nutritional status among adult literate women and women belonging to upper socio-economic groups using BMI and waist-to-hip ratio as indicators and to find out the different factors and pattern of some diseases/conditions influencing them.

Materials and methods

It was a descriptive cross-sectional study on the assessment of nutritional status using BMI and Waist-to-hip ratio among adult literate women belonging to upper socio-economic groups done for a period of one year in 2011. Institute ethics committee approval was obtained before the study. Considering a power of 80%, based on the prevalence of overweight/obesity (11), the sample size was calculated to be a minimum of 320. Participants included about 150 undergraduate (UG)/postgraduate (PG) residents studying various courses in medicine along with 150 nurses and 150 women residing in the various residential quarters of Dhanvantari Nagar, Puducherry. All the UG/PG female students were included without sampling. Nurses were selected by simple random sampling method & residents in quarters were selected by systematic random sampling by taking alternate houses. The demographic profile of the questionnaire included the following: Name, age, sex, education, working status, family income (per capita income was calculated later), marital status, obstetric

history, housemaid employed, physical activity, dietary practices, bodily perceptions, details of chronic diseases – diagnosis & treatment with the measurements of height, weight, & waist-to-hip ratio. All the three groups were interviewed with measurements of height, weight, waist, and hip circumference, after taking informed consent with a pre-tested interview schedule. BMI was calculated as weight in kilograms divided by height in meters squared (kg/m^2). Weight was measured by using a weighing machine with an accuracy of 100 g, and height was measured with an adjustable measuring tape with an accuracy to the nearest 0.1 (12). Waist circumference was measured at the level of the umbilicus with the subject in mid expiratory position. Hip circumference was recorded at the widest point over the greater trochanters, and the waist-to-hip ratio was calculated.

Statistical analysis

Frequencies/proportions were expressed in percentages. The statistical analysis was performed using SPSS for Windows version 16.0 software (SPSS, Chicago, USA). Chi-square test was used to compare the proportions wherever it is appropriate. A p-value < 0.05 was considered statistically significant.

Results

In the present study, the aim was to find out the proportion of overweight and obesity among the community which predominantly involved middle and high-income groups with the high level of literacy. BMI and waist-to-hip ratio was taken as indicators. 86.7% of the housewives belonged to levels less than diploma or degree. All the nurses were diploma holders. All the students were undergraduates. There were no illiterates in the study group. 94.7% of students were less than 25 years of age and majority of nurses and housewives were in the age group of 35-44 years. 89% of nurses were in the age groups 25-44 years compared to 66% among housewives. Similarly, 29% of housewives were in 45 years of age and above compared to 8% among nurses. These differences were found to be statistically significant. Further, 99.3% of students and 79.8% nurses

were in Prasad's Class I. 50.7% of housewives were in Prasad's class II. These differences were also found to be statistically significant. 42.1% of women were very active in the age group below 25 years. The range of other categories varied from 25.6% to 32.3%. The range of fairly active women was from 55.9% to 62.6 %. The percentage of not active women was lowest (1.8%) in the age group below 25 years and highest (15.7%) in the age group above 45 years followed by 10.4% in the age group 35 to 44 years and 5% in the age group 25 to 34 years. These differences were statistically significant. Only 19.5% of females below 25 years of age were participating in active housework, while 68.9% of women between 35 to 44 years were involved in the same. These differences were also statistically significant.

Prevalence of leanness, normal weight, overweight and obese females in different categories of age, occupation and socioeconomic levels

Table 1 shows the BMI distribution by age, occupation and socioeconomic status. 35.9% of women with normal BMI were in Prasad's class I followed by overweight (39.6%) and obese females (23.4%). The majority of obese females (31.3%) were in Prasad's class II category and 47.5% of overweight women were in Prasad's class II. These differences were not statistically significant. The proportion of overweight was ranging from 39.6% to 43%. Obesity was present in about one-third of all the age groups (33.3% – 35.4%) except in those aged 25 years where it was 6.3%. Obesity was highest in the age group of 25-34 years followed by 35-44 years, above 45 years and below 25 years. Overweight among the study subjects was ranging from 39.3% among nurses to 44.7% among housewives. These differences were statistically significant. The majority of the students were having normal BMI (54.7%) compared to 21.3% among housewives and 23.3% among nurses. Obesity was only 2.7% among students compared to 37.3 % among nurses and 34% of housewives. Only 2.7% of the students were undernourished. These differences were statistically significant.

Table1. Prevalence of leanness, normal weight, overweight and obese females in different age groups, occupation and socioeconomic scales

Age group	BMI CLASS									
	Leanness		Normal		Over weight		Obese		Total (N=450)	
	Number	%	Number	%	Number	%	Number	%	Number	
Above 45 years	0	0.0	14	24.6	24	42.1	19	33.3	57	Chi-Square = 63.18 (P <0.001)
35-44 years	0	0.0	30	22.2	58	43.0	47	34.8	135	
25-34 years	0	0.0	23	23.2	41	41.4	35	35.4	99	
Below 25 years	4	2.5	82	51.6	63	39.6	10	6.3	159	
Occupation										Chi-Square = 81.22 (P<0.001)
House wives	0	0.0	32	21.3	67	44.7	51	34.0	150	
Nurses	0	0.0	35	23.3	59	39.3	56	37.3	150	
Students	4	2.7	82	54.7	60	40.0	4	2.7	150	
Prasad's socio-economic scales										Chi-Square = 8.25 (P = 0.082)
Prasad's class I	4	1.1	129	35.9	142	39.6	84	23.4	359	
Prasad's class II	0	0.0	17	21.3	38	47.5	25	31.3	80	
Prasad's class III	0	0.0	3	27.3	6	54.5	2	18.2	11	

P–value shows the significant differences among various groups of BMI in relation to age, occupation and socioeconomic scales

Prevalence of normal weight, overweight and obese females in different categories

Table 2 shows the distribution of BMI class in the women according to their participation in active and strenuous work, like household chores, heavy gardening and manual work. 41.9% of obese females and 45.2% of overweight females feel that they are not very active. On the other hand, only 12.9% of females who have a normal BMI feel that they are not very active. The proportion of 'not very active' was higher among the overweight compared to those who were obese or had normal BMI. These differences were statistically significant. 32.9 % of obese females and 41.7% of overweight females were not doing active housework. On the other hand, only 25.4% of normal females feel that they were not doing active housework. 34.1% of obese females and 41.3% of overweight females were not doing heavy gardening and manual work when compared to 24.6% of normal females. Only 20.8% among the obese were doing gardening and manual work compared to 37.3% who were having normal BMI. These differences were statistically significant. 36.3 % of obese females and 40.3% of overweight fe-

males were having 2 or more children. 4.6% of obese females, 41.2% of overweight females, 54.2 % of females with normal BMI had no children.

Prevalence of leanness, normal weight, overweight and obese females according to medical illness

Table 3 shows the BMI class distribution according to the hypertensive status of women. Among the women who were found to be hypertensive, 37.2% were obese, 39.7% were overweight and 23.1% had a normal BMI. Among the women who were found to be non-hypertensive, 22% were obese, 41.7% were overweight and 35.2% had normal BMI. These differences were statistically significant. Of all the diabetics, 30% were obese and 43.8% were overweight while 22.9% of non-diabetics were obese and 353%% were overweight. These differences were not statistically significant.

Distribution of females based on waist-to-hip ratio

Table 4 shows the ages, occupation and socioeconomic status wise distribution of waist-to-hip ratio. 80.7% of females above 45 years, 77.8% of females be-

Table 2. Prevalence of normal weight, overweight and obese females based on the different activity and offspring

Activity	BMI CLASS						Chi-Square = 9.15 (P = 0.057)
	Normal		Over weight		Obese		Total (N=446)
	Number	%	Number	%	Number	%	Number
Very active	56	36.6	65	42.5	32	20.9	153
Fairly active	89	34.0	107	40.8	66	25.2	262
Not very active	4	12.9	14	45.2	13	41.9	31
Activity (House work)							Chi-Square = 20.88 (P <0.001)
Yes	91	41.7	91	41.7	36	16.5	218
No	58	25.4	95	41.7	75	32.9	228
Activity (Gardening & manual work)							Chi-Square = 11.36 (P = 0.003)
Yes	115	37.3	129	41.9	64	20.8	308
No	34	24.6	57	41.3	47	34.1	138
Total Children							Chi-Square = 69.65 (P <0.001)
No Children	83	54.2	63	41.2	7	4.6	153
1 Children	19	20.7	42	45.7	31	33.7	92
2 or Children	47	23.4	81	40.3	73	36.3	201

P-value shows the significant differences among various groups of BMI in relation to the different activity and offspring

Table 3. Prevalence of leanness, normal weight, overweight and obese females according to medical illness

Medical illness	BMI CLASS								
	Leanness		Normal		Over weight		Obese		Total (N=450)
	Number	%	Number	%	Number	%	Number	%	Number
Diabetics	0	0.0	24	25.0	42	43.8	30	31.3	96	Chi-Square = 5.22 (P = 0.073)
Non- Diabetics	4	1.1	125	35.3	144	40.7	81	22.9	354	
Hypertensives	0	0.0	18	23.1	31	39.7	29	37.2	78	Chi-Square = 9.36 (P = 0.009)
Non- Hypertensives	4	1.1	131	35.2	155	41.7	82	22.0	372	

P-value shows the significant differences among various groups of BMI in relation to medical illness

tween 35 to 44 years, 77.4 % of females less than 25 years and 71.7% of the females between 25 to 34 years had a high waist-to-hip ratio. 78% of housewives had a high waist-hip ratio followed by nurses and students (76%). A majority of nurses and students (24%) had a low waist-hip ratio followed by housewives (22%). Women with a high Waist-hip ratio (76.3%) were in Prasad's class I while women with low waist-hip ratio were in Prasad's class II. 76.9% of overweight female, 76.5% of normal women and 75% of underweight women had a high hip ratio. 50% of underweight females felt "I am overweight " and another 50% felt " I

am obese". About 33% of the normal women perceived their weight as normal. Similarly, only 39.2% of overweight women perceived "I am overweight" and 37.8% of the obese women perceived "I am overweight". Kappa test was done taking normal, overweight and obese. It showed poor agreement (0.048).

Discussion

The prevalence of overweight and obesity had increased slightly over the past decade in India. As-

Table 4. Distribution of females according to waist-to-hip ratio

SES	WAIST-HIP RATIO					
	High WHR		Low WHR		Total	
	Number	%	Number	%	Number	
Prasad's class I	274	76.3	85	23.7	359	Chi-Square = 3.50 (P = 0.174)
Prasad's class II	60	75.0	20	25.0	80	
Prasad's class III	11	100.0	0	0.0	11	
Age Group						
Above 45 years	46	80.7	11	19.3	57	Chi-Square = 2.01 (P = 0.570)
35-44 years	105	77.8	30	22.2	135	
25-34 years	71	71.7	28	28.3	99	
Below 25 years	123	77.4	36	22.6	159	
Occupation						
Housewives	117	78.0	33	22.0	150	Chi-Square = 0.22 (P = 0.894)
Nurses	114	76.0	36	24.0	150	
Students	114	76.0	36	24.0	150	

P-value shows the significant differences among various group of BMI in relation to waist–to–hip ratio

sociation of BMI with various socioeconomic and demographic factors were studied and it was found that the relationship between overweight and obesity with a place of residence and socioeconomic status cannot be generalized in Indian situation (13). NFHS 2005-2006 showed that there is a high prevalence among ever-married women (about 35%) and pre-school children (about 42%) (2). In the present study, undernutrition (BMI<18) was present in 4 (2.5%) study subjects. The proportions of normal nutrition (BMI 18-24.9), over weight (BMI 25-29.9), and obese (30 and above) were 33.3%, 42.1% and 24.6 % respectively. The age range was from 19-52 years. BMI class showed an increasing trend with age. Reddy et al have reported that mean BMI showed increasing trend until about 50 years, followed by a decline, indicating nonlinear nature of age effects (13). Distribution of BMI groups according to occupation showed that students about 60% had normal BMI compared to 23.3% among nurses and 21.3% among housewives. The proportion of overweight and obesity were highest among housewives followed by medical students and nurses. Both, years of schooling received and socioeconomic status is found to be important predictors of women's BMI in our study, which is almost similar to the study done by Shukla et al (14).

The positive association between socioeconomic status and BMI observed in the present study was qualitatively similar to the study done in rural Bangladesh and urban areas of Karachi but different from the negative association that characterizes contemporary Western population. The study conducted in rural Bangladesh to measure the influence of socio-economic factors on the chronic nutritional deficiency of women showed that women aged more than 35 years are twice as likely to have a BMI < 18.5 compared to younger women. Women who have also received one or more years of formal education are nearly half as likely to suffer chronic energy deficiency. The lack of association with parity was explained by the potential for low parity women to be severely energy deficient (15, 16). Similarly, the study conducted in urban areas of Karachi, Pakistan showed that among females, rates of underweight were not significantly different at any age. Rates of overweight increases significantly (P=0.048) with income level among 41 to 60-y-old

women (38%, 53% and 60% at low, middle & high-income levels respectively) (9). Interestingly, there were other factors which would have influenced overweight and obesity. One of them was the number of children and this showed a direct relationship with BMI groups. Thus, in the present study, overweight and obesity increased with the number of children borne by them. But in a study from Bangladesh, BMI was not related to the number of children (16).

There was a decreasing trend of physical activity (active work) compared with age. Higher proportions of younger women were either very active or fairly compared to women above 45 years. A similar trend was observed among the ethnic women in U.K (17). However, the proportions of young women "not active" were 44% compared to 12.9% in our study. The percentage of women doing housework varied from 64.6% in the age group of 25-34 years to 71.9% in the age group of above 45 years. Waist-to-hip ratio was high among 345 (76.6%) of the study subjects. The differences between various age groups were not statically significant. A similar difference with various occupations and BMI groups were also not statically significant. Waist-hip ratio was higher among 75-76.5 % of underweight and normal women & similarly 23.1 and 23.4 % women who were overweight and obese respectively had a lower waist-to-hip ratio. This is almost contradictory to the findings in different studies (18, 19). The reason being waist circumference may be a good indicator when compared to waist-hip-ratio.

In the present study, there was no agreement between body weight and perception. Even the underweight told that they were weighing normally. About 28% of overweight and 26% of obese said that they had normal weight. It was observed that the proportion of women "not very active" was more among obese women (11.7%) and overweight women (2.7%). Similar observations have been made among ethnic minorities in U.K (17). Similar findings were present with respect to household activity also. Since the study subjects were on the campus of an institution, the diagnosis of diabetes and hypertension were known to them. About 78 were suffering from hypertension and about 96 (21.3%) were suffering from diabetes. There was an increasing trend for both hypertension and diabetes with age. Though the proportion of overweight

and obesity were higher with diabetes. It was not statistically significant. However, there was a positive association of hypertension with overweight and obesity. It is well-known that relative risk of Non-insulin-dependent diabetes mellitus is significantly increased and that of hypertension moderately increases with obesity (20-22).

Thus, overweight/obesity has become an increasing burden among adult literate women. Although our study was undertaken with the aim of assessing the nutritional status of women belonging to upper socioeconomic status, it has its own limitation. One of the limitations could be different sampling techniques used for different groups because of convenience.

Conclusion

This was a descriptive study of assessment of nutritional status using BMI and waist-hip ratio among adult literate women and women belonging to upper socio-economic groups. Only about one thirds were having normal range of BMI. The rest were either overweight or obese. The factors influencing BMI groups were age, occupation, physical activity and the number of children. Diabetes and hypertension were associated with overweight and obesity. Waist-hip ratio showed that about 75% of study subjects had higher (>0.8) values. Thus, even though healthy lifestyle is a major concern today, still overweight/obesity becomes an increasing burden among adult literate women. Hence appropriate measures to monitor the trend of body weight towards overweight/obesity among women should be undertaken on a routine basis.

References

1. Prentice AM. The emerging epidemic of obesity in developing countries. Int J Epidemiol 2006; 35: 93-9.

2. Wang Y, Chen HJ, Shaikh S, Mathur P. Is obesity becoming a public health problem in India? Examine the shift from under- to overnutrition problems over time. Obes Rev 2009; 10: 456-74.

3. Naidu AN, Rao NP. Body mass index: a measure of the nutritional status in Indian populations. Eur J Clin Nutr 1994; 48 Suppl 3: S131-40.

4. Central obesity and risk of cardiovascular disease in the Asia Pacific Region. Asia Pac J Clin Nutr 2006; 15: 287-92.

5. Organization WH. The Asia-Pacific perspective: redefining obesity and its treatment. 2000.

6. WHO I. IOTF. The Asia-Pacific Perspective. Redefining Obesity and Its Treatment. Obesity: preventing and managing the global epidemic Geneva: WHO 2000.

7. Sengupta A, Angeli F, Syamala TS, Van Schayck CP, Dagnelie P. State-wise dynamics of the double burden of malnutrition among 15-49 year-old women in India: how much does the scenario change considering Asian population-specific BMI cut-off values? Ecol Food Nutr 2014; 53: 618-38.

8. Siddiqui ST, Kandala NB, Stranges S. Urbanisation and geographic variation of overweight and obesity in India: a cross-sectional analysis of the Indian Demographic Health Survey 2005-2006. Int J Public Health 2015; 60: 717-26.

9. Hakeem R. Socio-economic differences in height and body mass index of children and adults living in urban areas of Karachi, Pakistan. Eur J Clin Nutr 2001; 55: 400-6.

10. Mendez MA, Monteiro CA, Popkin BM. Overweight exceeds underweight among women in most developing countries. Am J Clin Nutr 2005; 81: 714-21.

11. Subramanian SV, Smith GD. Patterns, distribution, and determinants of under- and overnutrition: a population-based study of women in India. Am J Clin Nutr 2006; 84: 633-40.

12. Sengupta A, Angeli F, Syamala TS, Dagnelie PC, van Schayck CP. Overweight and obesity prevalence among Indian women by place of residence and socio-economic status: Contrasting patterns from 'underweight states' and 'overweight states' of India. Soc Sci Med 2015; 138: 161-9.

13. Reddy BN. Body mass index and its association with socioeconomic and behavioral variables among socioeconomically heterogeneous populations of Andhra Pradesh, India. Hum Biol 1998; 70: 901-17.

14. Shukla HC, Gupta PC, Mehta HC, Hebert JR. Descriptive epidemiology of body mass index of an urban adult population in western India. J Epidemiol Community Health 2002; 56: 876-80.

15. Islam MZ, Akhtaruzzaman M, Lamberg-Allardt C. Nutritional status of women in Bangladesh: comparison of energy intake and nutritional status of a low income rural group with a high income urban group. Asia Pac J Clin Nutr 2004; 13: 61-8.

16. Ahmed SM, Adams A, Chowdhury AM, Bhuiya A. Chronic energy deficiency in women from rural Bangladesh: some socioeconomic determinants. J Biosoc Sci 1998; 30: 349-58.

17. Heckler M. Report of the Secretary's task force on Black & minority health. 1985.

18. Ahmad N, Adam SIM, Nawi AM, Hassan MR, Ghazi HF. Abdominal obesity indicators: Waist circumference or

waist-to-hip ratio in Malaysian adults population. Int J Prev Med 2016; 7: 82.

19. Cheong KC, Ghazali SM, Hock LK et al. The discriminative ability of waist circumference, body mass index and waist-to-hip ratio in identifying metabolic syndrome: Variations by age, sex and race. Diabetes & Metabolic Syndrome: Clinical Research & Reviews 2015; 9: 74-8.

20. Organization WH. Obesity: preventing and managing the global epidemic: World Health Organization; 2000.

21. Gupta R, Rastogi P, Sarna M, Gupta V, Sharma S, Kothari K. Bodymass index, waist-size, waist-hip ratio and cardiovascular risk factors in urban subjects. J Assoc Physicians India 2007; 55: 621-7.

22. Meshram I, Vishnu VRM, Sudershan RV, Laxmaiah A, Polasa K. Regional variation in the prevalence of overweight/obesity, hypertension and diabetes and their correlates among the adult rural population in India. Br J Nutr 2016; 115: 1265-72.

————

Correspondence:
Dr. Dhananjay Yadav
Research Professor, Department of Medical Biotechnology, Yeungnam University Gyeongsan-Si, Gyeongbuk, Republic of Korea (712-749)
Phone: +821022021191
E-mail: dhanyadav16481@gmail.com