Factors affecting overweight and obesity among urban adults: a cross-sectional study

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ABSTRACT

BACKGROUND: the prevalence of overweight and obesity are increasing at an alarming rate in the developing countries. The present cross-sectional study assesses the prevalence of overweight and obesity along with their associated variables among urban adult individuals belonging to the Bengalee Hindu Caste Population (BHCP).

METHODS: the study has been carried out among 600 adult individuals belonging to the BHCP in the age group of 20-60 years and residing in the district of Jalpaiguri, West Bengal, India. Height and weight, along with a number of socio-economic, demographic and lifestyle variables were recorded. International cut off points of the body mass index were used to assess overweight (BMI ≥ 23.00 kg/m²) and obesity (BMI ≥ 25.00 kg/m²). The statistical tests (ANOVA, chi-square and multinomial logistic regression) were done using SPSS (version 15.00).

RESULTS: the prevalence of overweight and obesity were observed to be high among both the male (23.67% and 9.67%) and the female (20.33% and 29.33%) individuals. The sex difference was observed to be significant in case of obesity ($p<0.01$) and combined overweight-obesity ($p<0.01$). The multinomial logistic regression indicated that age and monthly income had significant effects on overweight ($p<0.05$). Sex, age, monthly income, marital status, education and alcohol intake were observed to have significant effects on obesity ($p<0.05$). Sex, age, monthly income and monthly income and marital status also showed significant effects with combined overweight-obesity (BMI ≥ 23.00 kg/m²) ($p<0.05$).

CONCLUSIONS: the prevalence of overweight and obesity exhibited an increasing trend among urban adults of the BHCP. Sex, age, marital status and monthly income were observed to have more influence on the prevalence of overweight and obesity among them. There appears to be an urgent need for the development of health strategies and intervention programmes for combating the consequences of overweight and obesity.

Key words: BMI; Overweight; Obesity; India; Bengalee

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INTRODUCTION

Overweight and obesity are now considered to be two very serious public health problems contributing to a number of preventable non-communicable diseases such as hypertension and diabetes mellitus. They substantially increase the risk of premature mortality and

morbidity and are recognized as conditions where excess of body fat accumulates to such degrees that the individual's health remains negatively affected [1, 2]. It has been observed that during the last few decades, obesity has been increasing at an alarming rate in both the developed and the developing countries [3, 4]. In fact, some studies have reported that the prevalence of obesity had already reached epidemic proportions in the developed countries [5, 6]. Although obesity has been generally attributed to genetic predispositions, the development of such epidemics around the world suggests that environmental risk factors are also equally responsible for its prevalence [7]. Individuals from the developed and the developing countries began to consume more quantities of high energy foods and exhibiting less physical activity. These led to the overweight and obesity epidemics around the world [8]. It has also been reported by the World Health Organization (WHO) that the susceptible individuals were often exposed to a lifestyle characterized by less physical activity, an abundant availability of energy dense, high fat and palatable foods and inappropriate meal patterns [9].

The body mass index (BMI) has been traditionally promulgated by the WHO as a useful indicator of obesity [9, 10]. This index has been considered as a marker of obesity because of its excellent correlation with body fat and is calculated as weight in kilograms divided by the height square in meters [10]. Innumerable number of studies have documented the prevalence of obesity and overweight among different populations using this index [7, 11-18].

A number of the developing countries typically portray high prevalences of under-nutrition. Interestingly, a significant proportion of the populations in these countries suffer from overweight and obesity. India is not an exception and recent trends have shown that the prevalence of overweight and obesity along with that of under-nutrition are major public health concerns in both the rural and sub-urban regions of the country [19-23]. A steady increase in the prevalence of overweight and obesity has already been reported from different Indian populations [11, 13, 14, 17, 24-26].

A number of demographic, biological, socio-cultural and behavioral factors have been observed to influence overweight and obesity [27]. However, few studies have focused on these factors while assessing the prevalence of overweight and obesity among adult Indian populations. In this context, the studies of Shukla et al. [11], Subramanian and Smith [13], Subramanian et al. [14] and Singh et al. [28] are mentionable. Therefore, the need arises to study the influence of the different demographic, biological, socio-cultural and behavioral factors that have the potential to influence the prevalence of overweight and obesity among Indian urban adults. The objectives of the present study are, therefore, to evaluate the prevalence of overweight and obesity among urban adult individuals and to document the effect of some socio-economic, demographic and lifestyle factors on their prevalence.

METHODS

Area, population and method of sampling

The present cross-sectional study has been carried out among 600 adult individuals aged between 20 years to 60 years and belonging to the Bengalee Hindu Caste Population (BHCP). All of them were residing in the district of Jalpaiguri, West Bengal, India. Ethnically, the BHCP is a Bengali-speaking endogamous caste group of West Bengal and faithful to Hinduism. They are probably a blend of Dravidian and Mongoloid ethnic groups with a strain of Indo-Aryan blood among the higher caste groups [29].

The district of Jalpaiguri (26°31'00"N; 88°44'00"E) is the largest district amongst the six districts of North Bengal and covers an area of 6 245 km^2. According to the 2011 National census, the district had a population of 3 869 675 individuals (males: 1 980 068; females: 1 889 607). The average literacy rate in 2011 was 73.79% (males: 80.61%; females: 66.65%). The data for the present study were collected from the northern part of Jalpaiguri Sadar Sub-Division in two phases, one from January 2010 to July 2010 and the other from April 2012 to May 2012.

A multi-stage stratified random sampling method was utilized to select the individuals in the present study. In the first stage, the households of individuals belonging to the BHCP were identified based on their surnames and physical characteristics. The information was subsequently verified from the official

records. In the second-stage, purposive random sampling was utilized to select the individuals to be included in the study. The male and female individuals belonging to the BHCP in the age group of 20 years to 60 years were subsequently identified to achieve the specific objectives. The individuals below and above the age range under study (20 years to 60 years) were excluded from the study. The age of the individuals was finally recorded from the birth certificates and the official records.

The minimum number of individuals required to reliably estimate the prevalence of overweight-obesity was calculated following the sample size estimation method of Lwanga and Lemeshow [30]. This method takes into consideration the anticipated population proportion of 50.00%, absolute precision of 5.00% and confidence interval of 95.00%. The minimum sample size was, thus estimated to be 384 individuals. The final sample size was however, higher than this number and consisted of two sex matched groups (males: 300; females: 300). Hence, the total number of individuals in the present study was 600.

All the individuals voluntarily participated in the present study. The objectives of the study were explained to them and their verbal consent was obtained prior to data collection. A pre-structured and pre-tested schedule was used to obtain the necessary information on age, sex, monthly income, occupation, nature of occupation, education status, marital status, family size, nature of family, physical exercise and the use of alcohol and tobacco. Individuals who regularly consumed alcohol (once or more than once per week) comprised the alcohol-use category. Individuals forming the tobacco-use group had a daily habit of cigarette smoking or chewing of tobacco.

Almost all the subjects were interviewed and measured at his/her respective household. It was only in some cases that the data was collected after the subjects had assembled in a common place. This was primarily due to the logistic issues involved. The subjects neither exhibited any physical deformity nor were suffering from any systematic disease. This was done mainly to avoid subject selection bias. Pregnant and lactating women were also excluded to avoid subject bias. The study was conducted in accordance with the ethical guidelines for human experiments as laid down in the Helsinki Declaration of 2000 [31].

Anthropometric measurements

Height and weight were recorded following standard procedures [32]. Height (height vertex) was measured to the nearest 0.10 cm using an anthropometer with the subject standing erect with the head in the Frankfort horizontal (ear-eye) plane. Weight was recorded to the nearest 0.50 kg with the subject standing motionless on a portable weighing machine. The measurements were recorded by two of the authors (NM and SD).

The intra-observer and inter-observer differences were calculated for testing the coefficient of reliability (R) of the measurements using the technical error measurement (TEM) of Ulijaszek and Kerr [33]. To determine the accuracy of the measurements, height and weight were recorded separately from 30 adult individuals by NM and SD. Very high R values (>0.98) were obtained for both intra-observer and inter-observer TEM analysis. As these values were within the cut-off value of 0.95 as suggested by Ulijaszek and Kerr [33], the measurements recorded by NM and SD were considered to be reliable and reproducible. TEM was calculated using the following formula:

$TEM = \sqrt{(\Sigma D^2/2N)}$

where D=difference between the measurements, N=number of individuals measured.

Assessment of overweight and obesity

The BMI was calculated using the following formula:

$BMI\ (kg/m^2) = Weight\ (kg)/\ Height\ (m^2)$

The WHO [34] had proposed a redefined criterion for overweight and obesity among Asian populations and this was used to evaluate the prevalence of overweight and obesity in the present study. The BMI cut-off points utilized for the assessment of overweight and obesity were ≥ 23.00 kg/m^2 and ≥ 25.00 kg/m^2 respectively. For combined overweight-obesity, the cut-off point was ≥ 23.00 kg/m^2.

Statistical analysis

The statistical analyses were done using the Statistical Package for Social Science (SPSS, Inc., Chicago, IL; version, 15.00). One way analysis

of variance (ANOVA) was done to assess sex differences in the anthropometric variables. Chi-square (χ^2) analysis was done to assess the sex differences in the prevalence of overweight and obesity. The difference in prevalence of overweight and obesity in the sub-categories of the different socio-economic, demographic and lifestyle factors were also analyzed utilizing χ^2 analysis. A multinomial logistic regression analysis was fitted to estimate the odd ratios (ORs). The 95.00% confidence interval (CI) was used to examine the possible differences between those with an individual being for overweight, obesity and overweight-obesity (BMI ≥ 23.00 kg/m^2) separately and allowing for controlling the different socio-economic, demographic and lifestyle related variables. To create the dichotomous dependency variables, individuals observed to be overweight (BMI ≥ 23.00 kg/m^2), obese (BMI ≥ 25.00 kg/m^2) and both overweight and obese (BMI ≥ 23.00 kg/m^2) were coded as '0' while those individuals with normal BMI (BMI < 23.00 kg/m^2) were coded as '1' in the multiple logistic regression model respectively. The predictor variables of sex (male and female), age (<30 years, 31-45 years and 46-60 years), family type (joint/extended and nuclear), family size (≤4 and ≥5), monthly income (<Rs. 10 000 and ≥ Rs.10000), education (≤ 8th standard and ≥ 9th standard), occupation (full time and part time), alcohol intake (regular/occasional and never) and use of tobacco (yes and no) were entered in the regression equation and the results were obtained by comparing them with the reference category. The p values of <0.05 and <0.01 were considered to be statistically significant.

RESULTS

Descriptive statistics

The descriptive statistics (mean and standard deviation) and 95.00% CIs of the means of height, weight among the male and the female individuals are shown in Table 1. The results show that the male individuals were taller and heavier than their female counterparts. The mean height and weight were significantly higher (p<0.01) among the males (163.94±6.03 cm and 57.88±8.76 kg) than the females (151.35±5.63 cm and 53.15±8.35 kg). Using ANOVA, the sex differences in height and weight were statistically significant. For weight, the F value was 45.83 (d.f. 1,599; p<0.01), while for height, it was 698.21 (d.f. 1,599; p<0.01). The mean BMI observed to be significantly (p<0.01) higher among females (23.19±3.28 kg/m^2) when compared with males (21.50±2.82 kg/m^2). Using ANOVA, the sex difference in BMI was also observed to be statistically significant (F value= 45.25; d.f. 1,599; p<0.01).

Prevalence of overweight and obesity

The prevalence of overweight and obesity among the BHCP individuals based on BMI is depicted in Table 2. The overall prevalence of overweight (BMI ≥ 23.00 kg/m^2) and obesity (BMI ≥ 25.00 kg/m^2) was documented to be 22.00% and 19.50% respectively. The prevalence of overweight was higher among the male as compared to the female individuals (23.67% versus 20.33%). However, the prevalence of obesity was distinctively higher among females as compared to the males (29.33% versus 9.67%). Statistically significant sex differences have been observed in the prevalence of obesity (χ^2 = 25.07, d.f.: 1; p<0.01) and overweight-obesity (χ^2 = 6.84, d.f.: 2; p<0.01). However, the sex difference was statistically not significant in case of overweight (χ^2 = 0.62, d.f.: 1; p>0.05). The overall and sex specific prevalence of overweight and obesity, excluding the individuals with normal BMI, are graphically represented in Figure 1.

Effect of the socio-economic, demographic and lifestyle related variables on overweight-obesity (BMI ≥ 23.0 kg/m^2)

The differences in the prevalence of overweight and obesity with respect to the different socio-economic, demographic and lifestyle related variables are shown in Table 3. Using χ^2 analysis, the prevalence of overweight was significantly different with respect to age (χ^2 = 12.45; d.f.: 2; p<0.01) and monthly income (χ^2 = 7.03; d.f.: 1; p<0.01). The prevalence of obesity was significantly different with respect to sex (χ^2 = 25.07; d.f.: 1; p<0.01), age (χ^2 = 7.95; d.f.: 2; p<0.05), monthly income (χ^2 = 11.13; d.f.: 1; p<0.01), marital status (χ^2 = 15.10; d.f.: 1; p<0.01) and education (χ^2 = 4.57; d.f.: 1; p<0.05). The

TABLE 1

MEAN ± STANDARD DEVIATION (95 % CONFIDENCE INTERVAL OF THE MEANS) OF HEIGHT, WEIGHT AND BMI AMONG THE INDIVIDUALS

ANTHROPOMETRIC VARIABLES	MALE (N=300)	FEMALE (N=300)	SEX DIFFERENCE USING ANOVA		
			F-VALUE	D.F.	P
WEIGHT (kg)	57.88±8.76 (95% CI: 56.88-58.87)	53.15±8.35 (95% CI: 52.19-54.10)	45.83	1,599	<0.01
HEIGHT (cm)	163.94±6.03 (95% CI: 163.26-164.63)	151.35±5.63 (95% CI: 150.71-151.99)	698.21	1,599	<0.01
BMI (kg/m²)	21.50±2.82 (95% CI: 21.18-21.82)	23.19±3.28 (95% CI: 22.81-151.99)	45.25	1,599	<0.01

TABLE 2

PREVALENCE OF OVERWEIGHT AND OBESITY AMONG THE INDIVIDUALS USING BMI

CATEGORY	MALE (N=300)	FEMALE (N=300)	TOTAL (N=600)	SEX DIFFERENCE USING χ^2 ANALYSIS		
				χ^2 VALUE	D.F.	P
NORMAL (<BMI 23.00 kg/m²)	200 (66.67)	151 (50.33)	351 (58.50)	4.33	1	<0.05
OVERWEIGHT (≥BMI 23.00-24.99 kg/m²)	71 (23.67)	61 (20.33)	132 (22.00)	0.62	1	>0.05
OBESITY (≥BMI 25.00 kg/m²)	29 (9.67)	88 (29.33)	117 (19.50)	25.07	1	<0.01
OVERWEIGHT-OBESITY (≥BMI 23.00 kg/m²)	100 (33.33)	149 (49.67)	249 (41.50)	6.84	1	<0.01

Values in parenthesis indicates percentages

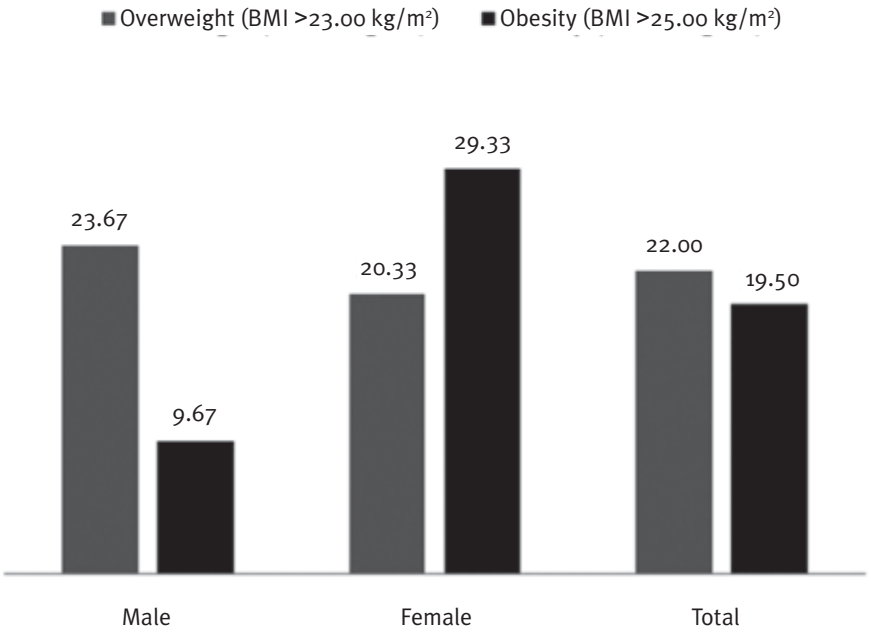
differences in the prevalence of overweight was observed to be statistically insignificant (p>0.05) in case of sex (χ^2 = 0.62; d.f.: 1), family type (x^2 = 0.41; d.f.: 1), family size (χ^2 = 0.09; d.f.: 1), marital status (χ^2 = 0.38; d.f.: 2), education (χ^2 = 1.00; d.f.: 2), occupation (χ^2 = 1.32; d.f.: 1), alcohol intake (χ^2 = 0.15; d.f.: 1) and use of tobacco (χ^2 = 0.12; d.f.: 1). In case of obesity, the differences were observed to be statistically insignificant (p>0.05) in case of family type (χ^2 = 1.80; d.f.: 1), family size (χ^2 = 0.01; d.f.: 1), occupation (χ^2 = 2.25; d.f.: 1), alcohol intake (χ^2 = 2.46; d.f.: 1) and use of tobacco (χ^2 = 0.15; d.f.: 1).

A multinomial logistic regression model was fitted onto the data to observe the odds for the socio-economic, demographic and lifestyle related variables to an individual being overweight and obese (Table 3). The results indicated that those individuals belonging to the higher monthly income bracket (Rs. ≥ 10 000) (odds: 2.07; 95% CI: 1.33-3.23; p<0.01) and middle age group (31-45 years) (odds: 2.45; 95% CI: 1.46-4.31; p<0.01) appeared to have higher significant risks of being overweight. The results further indicated that there were significant effects of sex (female) (odds: 3.88; 95% CI: 2.54-6.12; p<0.01), middle age group (31-45 years) (odds: 2.68; 95% CI: 1.47-4.89; p<0.01) and higher age group (45-60 years) (odds: 2.43; 95% CI: 1.27-4.64; p<0.01), ≥ Rs. 10 000 monthly income (odds: 2.65; 95% CI: 1.62-4.33; p<0.01), marital status married (odds: 5.25; 95% CI: 2.38-11.59; p<0.01), education ≤ 8th standard (odds: 0.53; 95% CI: 0.32-0.87; p<0.05) and alcohol intake (odds: 0.60; 95% CI: 0.36-1.00; p<0.05) to an individual being obese (Table 3).

Apparently, the odds of an individual

FIGURE 1

PREVALENCE OF OVERWEIGHT (BMI >23.00 kg/m²) AND OBESITY (BMI >25.00 kg/m²) AMONG THE INDIVIDUALS



being overweight was significantly higher among the females than the males (odds: 1.97; 95% CI: 1.42-2.75; p<0.01). The joint family type and family income of ≥ Rs. 10 000 per month showed significant higher risks in terms of odds (odds 1.40; 95% CI: 1.01-1.6; p<0.05 and odds: 2.99; 95% CI: 2.07-4.32; p<0.01) respectively for an individual being overweight as compared. When the effects of marital status and education were taken into consideration, individuals belonging to the married category exhibited higher odds (odds: 2.55; 95% CI: 1.64-3.96; p<0.01), while those in the ≤ 8th standard education showed lower odds (odds: 0.56; 95% CI: 0.39-0.81; p<0.01). Age showed significantly higher effects among those in the middle aged (31-45 years) (odds: 3.41; 95% CI: 2.20-5.30; p<0.01) and higher aged (45-60 years) (odds: 1.73; 95% CI: 1.07-2.82; p<0.05) groups for individuals being overweight and obese when compared to those from the younger ages (Table 3).

DISCUSSION

An effective management of the obesity endemic requires the establishment of the social, cultural, economic, educational and environmental factors involved in determining the weight of the populations [35]. The problem is compounded by the fact that many of the widely used terms like *"Asians"* and *"Indians"* encompass a vast population diversity based on ethnicity, culture, degree of urbanization, socio-economic conditions and nutritional transitions [36]. It was also observed that there has been increases in the incidences of various obesity related health risk factors among individuals from the Asian countries [9, 34]. Individuals belonging to the *"Asian"* populations were observed to be particularly vulnerable to obesity-related diseases along with co-morbidities. It was also evident that body fat distribution patterns were population, sex and age specific and that increases in obesity levels and fat compositions varied considerably between different ethnic populations [37, 38]. These resulted in a reclassification for the assessment of overweight among adult *"Asian"* individuals using BMI by the WHO. The new-cut-off points of BMI thus proposed were ≥ 23.00 kg/m² for overweight and ≥ 25.00 kg/m² for obesity [34].

A review of the different cross-sectional studies that studied the relationship between obesity and socio-economic status observed that obesity was a health problem of individuals mostly comprising the higher socio-economic groups in the developed countries and was the

highest among the lower socio-economic groups [39]. This picture has, however, changed radically during the past two decades as the rates of obesity have tripled in the developing countries [40]. Data from the developing countries suggested that the shift in the incidence of obesity was towards the

TABLE 3

SOCIO-ECONOMIC, DEMOGRAPHIC AND LIFESTYLE-RELATED VARIABLES AND RESULTS OF THE MULTINOMIAL LOGISTIC REGRESSION ANALYSIS FOR OVERWEIGHT-OBESITY (BMI ≥ 23.00 kg/m²) AMONG THE INDIVIDUALS

VARIABLES		NUMBER OF INDIVIDUALS (N=600)	OVERWEIGHT (23-24.99 kg/m²)	OBESITY (≥25.00 kg/m²)	OVERWEIGHT (23-24.99 kg/m²)			OBESITY (≥25.00 kg/m²)			OVERWEIGHT AND OBESITY (≥ 23.00 kg/m²)		
			N=132	N=117	B	ODDS	95% CI	B	ODDS	95% CI	B	ODDS	95% CI
SEX	Male ®	300	71 (23.67)	29 (9.67)	-	1	-	-	1	-	-	1	-
	Female	300	61 (20.33)	88 (29.33)	-0.19	0.82	0.56-1.21	1.36	3.88**	2.54-6.12	0.68	1.97**	1.42-2.75
AGE (IN YEARS)	Up to 30 ®	148	22 (14.86)	15 (10.14)	-	1	-	-	1	-	-	1	-
	31-45	280	84 (30.00)	65 (23.21)	0.90	2.45**	1.46-4.13	0.99	2.68**	1.47-4.89	1.23	3.41**	2.20-5.30
	46-60	172	26 (15.12)	37 (21.51)	0.02	1.02	0.55-1.89	0.89	2.43**	1.27-4.64	0.55	1.73*	1.07-2.82
TYPES OF FAMILY	Joint/ Extended	232	55 (23.71)	53 (22.84)	0.61	1.17	0.79-1.74	0.34	1.41	0.94-2.12	0.34	1.40*	1.01-1.76
	Nuclear ®	386	77 (19.95)	64 (16.58)	-	1	-	-	1	-	-	1	-
FAMILY SIZE	≤4 ®	408	88 (21.57)	79 (19.36)	-	1	-	-	1	-	-	1	-
	≥ 5	192	44 (22.92)	38 (19.79)	0.08	1.08	0.71-1.63	0.03	1.03	0.67-1.58	0.07	1.08	0.76-1.52
MONTHLY INCOME	< Rs. 10000 ®	213	31 (14.55)	23 (10.80)	-	1	-	-	1	-	-	1	-
	≥ Rs. 10000	387	101 (26.10)	94 (24.29)	0.73	2.07**	1.33-3.23	0.98	2.65**	1.62-4.33	1.10	2.99**	2.07-4.32
MARITAL STATUS	Married	472	107 (22.67)	110 (23.31)	0.19	1.21	0.74-1.97	1.66	5.25**	2.38-11.59	0.94	2.55**	1.64-3.96
	Unmarried ®	128	25 (19.53)	7 (5.47)	-	1	-	-	1	-	-	1	-
EDUCATION	≤ 8^{std}	176	33 (18.75)	23 (13.07)	-0.28	0.76	0.49-1.18	-0.64	0.53*	0.32-0.87	-0.58	0.56**	0.39-0.81
	> 9^{std} ®	424	99 (23.35)	94 (22.17)	-	1	-	-	1	-	-	1	-
OCCUPATION	Full time ®	276	68 (24.64)	45 (16.30)	-	1	-	-	1	-	-	1	-
	Part time	324	64 (19.75)	72 (22.22)	-0.28	0.75	0.51-1.11	0.38	1.47	0.97-2.22	0.04	1.04	0.75-1.45
ALCOHOL INTAKE	Never ®	444	96 (21.62)	95 (21.40)	-	1	-	-	1	-	-	1	-
	Occasional/ Regular	156	36 (23.08)	22 (14.10)	0.08	1.09	0.70-1.68	-0.51	0.60*	0.36-1.00	-0.24	0.78	0.54-1.14
USE OF TOBACCO	Yes	299	68 (22.74)	56 (18.73)	0.09	1.09	0.74-1.60	-0.10	0.91	0.61-1.36	-0.002	0.99	0.72-1.38
	No ®	301	64 (21.26)	61 (20.27)	-	1	-	-	1	-	-	1	-

Values in parenthesis indicates percentages, *p<0.05, **p<0.01, CI=confidence intervals, ®=reference category

poorer groups and tended to be higher among the females than the males [41]. A WHO study had reported that sudden urbanization increased the prevalence of obesity in the developing countries and that in the developed countries, the prevalence was higher in the rural areas when compared with the urban areas [42]. In the present study, the odds value showed that the female individuals exhibited almost a four folds significantly higher risk factor than the males for being obese ($p<0.01$). Existing studies in India have also observed that the magnitude of obesity was higher among the females than the males [26, 43, 44]. The prevalence of overweight and excessive thinness had also been simultaneously reported among the populations of four of the largest economically developing nations (India, Brazil, China and Russia) by Kapoor and Anand [45]. These four nations currently present several levels of transitions in terms of nutrition, health, economy, demography, society and environment. The economic transition, with its effect on all levels of the population, appear to be the strongest factor involved in the rise of overweight and/or obesity, but again there could be specific factors that differentiated the observed situation of a particular region or country.

The incidence of obesity in the present study (males: 9.67%; females: 29.33%) was lower than that of overweight (males: 23.67%; females: 20.33%) (Figure 1). Gopinath et al. [43] reported a higher prevalence of obesity among urban males and females from Delhi (males: 21.30%; females: 33.40%). Visweswara Rao et al. [46] also observed a higher prevalence of obesity among female individuals (36.30%) belonging to high socio-economic groups of Andhra Pradesh. In their study among individuals residing in North India, Dudeja et al. [44] also documented a higher incidence of obesity among both males and females (males: 15.10%; females: 27.00%). Very recently, Garg et al. [17] compared the results of two National Family Health Surveys (NFHS), one being NFHS-2 conducted in 1998-1999 while the other being NHFS-3 conducted in 2005-2006. It was observed that the overall prevalence of obesity among Indian women had risen from 10.60% to 12.60%. These results were, however, lower than those obtained for the BHCP in the present study. The reported prevalence of overweight-obesity in the present study was observed to be higher than those reported by Masoodi et al. [26] among adults of North India (Kashmir valley) (overweight-obesity: 16.30%; obesity: 5.10%). In another recent study, Mungreiphy and Kapoor [25] reported a higher prevalence of overweight (25.10%) and a lower prevalence of obesity (2.00%) among Tangkhul Naga female individuals from North-eastern India. A very recent large Indian survey [47] reported a lower prevalence of overweight and obesity among individuals aged 15 years to 49 years (overweight: 9.80%; obesity: 2.80%). All these studies, including the present study go on to suggest that the prevalence of overweight and obesity appear to be increasing among urban adults of this country.

The independent effect of socio-economic status on individuals being overweight and obese has been already established in adult populations [48]. On one hand, income was a primary socio-economic indicator associated with adiposity in the developing countries, and on the other, it was education in the developed countries [39]. Based on the multinomial logistic regression analysis, the present study has observed that individuals belonging to the higher income group (≥Rs.10 000) exhibited significantly higher odds to being overweight and obese than those belonging to the lower income group (<Rs.10 000) ($p<0.01$). It was suggested by Subramanian et al. [14] that the average levels of the states' economic development were strongly associated with over-nutrition among married Indian women. Studies have also reported that education had an inverse effect on weight gain in the developed countries [35, 49]. It was reported by Shafique et al. [15] that rural women with at least 14 years of education were observed to exhibit an 8.10 fold increased risk factor of being overweight as compared with non-educated women in Bangladesh. Azmi et al. [50] reported that the prevalence of higher adiposity using BMI was observed to be the highest for those individuals with primary education among Malaysian adults. In the present study, the odds were found to be significantly lower among the less educated adults (education level: ≤8th standard). A significant risk of overweight and obesity were observed as the level of education increased. The finding of the present study confirmed the significant effect between overweight-obesity and education, as reported in the afore-mentioned studies and also that of Al-Mahroos and Al-Roomi [51].

The present study further observed that

those individuals belonging to the middle ages (31-45 years) and higher ages (46-60 years) had a 2.50 fold significantly higher risk factor for being obese than individuals belonging to lower aged group (≤30 years). However, combined adiposity (overweight-obesity) as defined by BMI ≥ 23.00 kg/m^2, showed significantly higher risk factors with the middle aged (31-45 years) and higher aged (46-60 years) individuals, respectively. The increase in the odds for overweight and obesity can be related to age-affected body fatness which is well established [16]. Individuals belonging to the higher age groups exhibited higher mean BMI values and a higher prevalence of overweight and obesity [16, 52]. The increase of overweight and obesity among the middle and higher aged individuals could be attributed to the accumulation of body fat, increased energy intake, a fat-rich diet and relatively less energy expenditure due to lesser involvement in physical activities and a general modification in lifestyles. The results of the logistic regression model also suggested that marital status had a significant effect on overweight and obesity. The married individuals were more likely to be overweight-obese than the unmarried ones. The odds values were 5.00 fold and 2.50 fold higher for being obese ($p<0.01$) and overweight-obese ($p<0.01$) respectively (Table 3). Similar associations were earlier also reported by Tur et al. [7] and Jeffery and Rick [53]. The results further suggested that alcohol intake had a significant effect with obesity ($p<0.05$), thus confirming the effect of weight gain with alcohol intake as advocated in the earlier studies of Tur et al. [7] and Wannamethee and Shaper [12].

The cross-sectional design of the present study represented a difficulty to draw some major conclusions. But, it is worthwhile to mention here that the finding of the present study were based on two of the most important anthropometric variables (height and weight) and an index (BMI) which were in turn associated with a large number of socio-economic, demographic and lifestyle-related variables. In conclusion, the present study has explored the association of different related factors with the prevalence of overweight-obesity among an urban population in India. The prevalence of overweight and obesity showed an upward trend mainly as a result of improvement in the socio-economic conditions, urbanization, better nutrition, growing knowledge and awareness and sedentary life styles. It also may be concluded that most of the socio-economic and demographic and lifestyle related factors were significantly negatively associated with the prevalence of overweight and obesity. It is also evident that this prevalence represents a public health problem as it increases the economic burden and health risk factors. It is conjectured that for an effective management of the overweight and obesity epidemic, the needs are to establish the social, cultural, economic, educational and environmental factors involved in the weight status of the populations concerned as opined earlier by Martínez et al. [35]. The findings of the present study are, therefore, important for any public health programme to be successful. Moreover, there appears to be an urgent need to develop suitable health strategies as well as intervention programmes for combating the prevalence of overweight and obesity.

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