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Prevalence of Undernutrition and Overweight or Obesity Among the Bengali Muslim Population of West Bengal, India

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ABSTRACT

Background
Poor nutritional conditions, as well as excess adiposity levels, are the major public health problems of developing countries like India.

Objectives
The aim of the present investigation were to assess the prevalence of undernutrition and overweight or obesity and their associations with certain socio-economic and demographic variables.

Subjects and Methods
The present community-based cross-sectional investigation was undertaken among 420 adult Bengali Muslim individuals (males: 182; females: 238) aged 18-59 years and residing in rural areas of Uttar Dinajpur district, West Bengal, India. Anthropometric measurements of height and weight were recorded using standard procedures and Body mass index (BMI= Weight/Height kg/m^2) was calculated. Prevalence of undernutrition (BMI<18.50 kg/m^2) and overweight or obesity (BMI≥25.00 kg/m^2) were determined using World Health Organization (WHO) cut-offs. The statistical analyses of descriptive statistics, ANOVA, chi-square analysis and binary logistic regression (BLR) analysis was performed using SPSS, Inc., Chicago, IL USA; version 17.0.

Results
The overall mean height (164.22 cm *vs.* 152.65 cm), weight (57.03 kg *vs.* 48.70 kg) and BMI (21.18 kg/m^2 *vs.* 20.89 kg/m^2) were observed to be significantly higher among men than women (p<0.05). The overall prevalence of undernutrition and overweight or obesity were observed to be 22.86% and 12.86%, respectively. The BLR analysis showed associations of lower age group (i.e., 20-29 years) (odds ratio: 1.65) (p<0.05) and occupation (odds ratio: 5.61) (p<0.01) with undernutrition. Overweight or obesity was also observed to be statistically significantly associated with smaller family size (odds ratio: 2.09) (p<0.05).

Conclusion
The present investigation indicates the simultaneous existence of double burden of malnutrition (i.e., both under- and overnutrition) among the Bengali Muslim adults of West Bengal, India. Appropriate intervention programmes are necessary to improve the overall nutritional situation.

Keywords
Anthropometry; Bengali Muslim; Body mass index (BMI); Overweight or Obesity; Undernutrition; Public health; India.

Abbreviations
BLR: Binary Logistic Regression; BMP: Bengali Muslim Population; DBM: Double Burden of Malnutrition; BMI: Body Mass Index; ORs: Odds Ratios; SES: Socio-economic Status; CIs: Confidence Intervals; WB: West Bengal.

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INTRODUCTION

The co-existence of undernutrition and overweight or obesity among populations is, known as the "double burden of malnutrition (DBM). The DBM is a major public health problem contributing to high mortality and morbidities among populations worldwide. India has achieved positive economic growth, but there persists substantial economic nutritional inequalities and insufficiencies (e.g., malnutrition).[1-8] On one hand, a large proportion of the population of the country is suffering from severe to moderate undernutrition and on the other, there is the major problem of overweight or obesity. Recent studies have documented prevalence of a DBM which in turn, increases the burden of non-communicable diseases (NCDs) mainly in the developing countries.[3,5,9-13] The simultaneous occurrence of both under- and overnutrition (e.g., overweight or obesity) within a population is likely to reflect the differential distribution of resources at the individual or household level, i.e., some people do not have sufficient resources to meet their caloric requirements, while others have the resources to purchase their calorie requirements and more.[1,2,6-8] Several investigations demonstrated that a vast proportion of the population belongs to the underprivileged and undernourished segments in India.[12,14-16] Recent studies have now observed that a considerable amount of overweight or obesity exist among Indian populations.[2,5,13,17-22] Recent trends have indicated that the prevalence of overweight or obesity are also increasing among women belonging to lower socio-economic status in India.[2,4,5,12,23,24] Studies also have documented the associations of several socio-economic, demographic and lifestyle variables on the prevalence of overweight or obesity.[2,5,13,21,25] Therefore, it becomes necessary to understand the actual magnitude of malnutrition among the rural and marginalised populations of India. Several research studies have been conducted on various aspects of undernutrition among its populations.[26-30]

Overweight or obesity is a physical condition that contribute to the prevalence of numerous non-communicable diseases within populations. A steady increase in the prevalence of overweight or obesity has been reported from different Indian populations.[3,17-21,25,31-33] Recent studies have also suggested that this 'double burden' is becoming increasingly apparent in addition to the burden of non-communicable diseases affecting developing countries such as India.[2,10,22,34,35] However, undernutrition still remains a consistent public health problem among populations in the country.[36]

Anthropometry is a universally applicable, widely used, highly valid, inexpensive, and non-invasive technique available to researchers in the assessment of nutritional status.[37-40] Body mass index (BMI) is widely used, non-invasive, inexpensive anthropometric indicator to determine the nutritional status (both under and overnutrition) across populations for large-scale epidemiological and clinical investigations.[1,4,5,18,19,21,25,32,40-44] Extensive studies have been done using BMI as an indicator for assessing undernutrition[5,42,45-47] and overweight or obesity.[1,2,31,48,49]

There is a scarcity of studies on nutritional status among the Bengali Muslim Population (BMP) of India. The objectives of the present investigation was to determine and compare the prevalence of under-and overnutrition and their associations with certain socio-economic and demographic determinants among the BMP in a rural area of West Bengal, India.

MATERIALS AND METHODS

The present community-based cross-sectional investigation was carried out among 420 adult BMP individuals (males: 182; females: 238) aged 18-59 years residing in rural areas of Islampur subdivision of Uttar Dinajpur district, West Bengal, India. The Islampur subdivision (Latitude 26.27°N, Longitude 88.20°E) covers an area of 3142 km^2. According to 2011 National Census, India, Islampur had a population of 308,518 (males: 51.54%; females: 48.48%). The region is predominantly inhabited by the BMP and Hindus. The BMP is the largest religious minority population in West Bengal and comprises a considerable percentage of the state's population.[50] According to the census of 2011, the Muslim population constituted 27.10% of West Bengal's total population. Hindus and Muslims share more than 97% of the total population of the state.[50] Ethnically, the BMP is a Bengali-speaking ethnic community and by religion faithful to the Islam.[51] They contribute a large share to the social and economic well-being of the state and of the country as a whole. Therefore, it becomes important to assess the nutritional conditions of this population.

The individuals in the present investigation were selected using a stratified sampling method. Initially, the BMP individuals were identified in the present investigation based on their surnames and the data was verified from the block office records. Individuals belonging to the age group 18-59 years were then identified. Age of the subjects was recorded from their birth certificates and relevant official records issued by the local government officials. The minimum number of individuals required for reliably estimating the prevalence of overweight and obesity in the present investigation was calculated following a standard method of estimating sample size.[52] In this method, the anticipated population proportion of 50%, absolute precision of 5% and confidence interval of 95% were taken into consideration. The investigation was conducted in accordance with the ethical guidelines for human experiments, as laid down in the Helsinki Declaration of 2000.[53] Research permission to conduct the present investigation was obtained from the Department of Anthropology, University of North Bengal. Local leaders and authorities at community levels were informed prior to initiating the present investigation. The individuals were free from any physical deformities, previous histories of medical and surgical episodes and not suffering from any disease at the time of data collection. The data for this present investigation was recorded from January 2016 to April 2016.

Anthropometric Measurements

Anthropometric measurements were recorded using standard anthropometric procedures.[54] The height of the individuals was recorded to the nearest 0.1 cm with help of an anthropometer rod with the head held in the Frankfort horizontal plane. The weight of the individuals wearing minimum clothing and was taken with bare feet using a portable weighing scale to the nearest 100 gm. The individuals were measured with ample precision for avoiding

any possible systematic errors of anthropometric data collection (e.g., instrumental or landmarks).[55]

Intra-observer and inter-observer technical errors of the measurements (TEM) were calculated to determine the accuracy of the anthropometric measurement using the standard procedure.[56] For calculating TEM, height and weight were recorded from different data set of 50 adults other than those selected for the investigation by Pushpalata Tigga (PT), Sampriti Debnath (SD) and Mousumi Das (MD). The coefficient of reliability (R) of the measurements were calculated for testing the reliability of the measurements. Very high values of R (>0.975) were obtained for height and weight and these values were observed to be within the recommended a cut-off limit of 0.95.[56] Hence, the measurements recorded by PT, SD, and MD were considered to be reliable and reproducible. All the measurements in the present investigation were subsequently recorded by MD.

Socio-economic, Socio-demographic and Lifestyle Data

Data on age, sex, family size, toilet facility, house type, occupation and household income were collected using a structured schedule by visiting the households. A modified version of Kuppuswamy's socio-economic scale was used to evaluate the socio-economic status (SES).[57,58] The SES determination showed that all the individuals belonged to a lower-middle SES.

Assessment of Nutritional Status

Nutritional status has been assessed in terms of BMI. The BMI was calculated using the standard equation of the World Health Organization (WHO) (WHO 1995): BMI=Weight/Height^2 (kg/m^2)

The BMI cut-off points utilized for the assessment of undernourished and overweight or obesity were <18.50 kg/m^2 and ≥25.00 kg/m^2 respectively.[37]

Statistical Analysis

The data were statistically analyzed using the Statistical Package for Social Sciences (SPSS, Inc., Chicago, IL, USA; version 17.0). The descriptive statistical analysis of the data obtained was depicted in terms of mean and standard deviation (±SD). One way ANOVA has been performed to test the age-specific mean differences in anthropometric variables of the groups. Chi-square (χ^2) analysis was used to assess sex-specific differences in the prevalence of undernutrition and overweight. Chi-square analysis was also applied to assess differences in nutritional status between different socio-economic and demographic variables. Binary logistic regression (BLR) analysis was undertaken to estimate the odds ratios (ORs), minimum of 95% confidence intervals (CIs) and to assess possible differences in risk factors associated with those individuals being undernourished (BMI<18.50 kg/m^2) and combined-overweight and obesity (BMI≥25.00 kg/m^2), separately. In the BLR analysis, the different socio-economic, demographic and lifestyle predictor variables were used as univariate independent regression model analyses. To create the dichotomous dependent variables, individuals who were undernourished (BMI<18.50 kg/m^2) were coded as '1' in the respective BLR model. Similarly, individuals who happen to be combined overweight and obese (BMI≥25.00 kg/m^2) were also coded as '1' in the respective BLR model. Individuals who exhibited normal BMI were coded as '0' in the BLR models. These different regression models were utilized to identify possible risk factor(s) associated with undernutrition and excess adiposity levels (overweight or obesity). The BLR analysis allows the creation of categorical depended variables and odds ratios were obtained by comparing with the reference categories. The predictor variables of sex, age, family size, toilet facility, house type, occupation and income were entered in the regression equation and the results were obtained by comparing them with the reference categories. The p values of <0.01 and <0.05 were considered to be statistically significant.

RESULTS

The sex-specific distribution of subjects, age groups, means, and standard deviations of height, weight, and BMI are shown in Table 1. The overall mean height and weight were observed to be higher among males than that of females. Age group-specific means of height of males ranged from 162.53 cm (in 40-49 years) to 165.46 cm (in 20-29 years). In females, the age group-specific means of height ranged from 150.49 cm (in 50-59 years) to 154.09 cm (in 39-39 years). Age group specific weight among males ranged from 55.03 kg (in 20-29 years) to 60.61 kg (in 30-39 years). Among females, the age group-specific means of weight ranged from 45.34 kg (in 50-59 years) to 53.13 kg (40-49 years). Age group-specific mean values of BMI among males ranged from 20.15 kg/m^2 (in 20-29 years) to 22.60 kg/m^2 (30-39 years). Among females, the age group specific mean values ranged from 19.95 kg/m^2 (50-59 years) to 22.82 kg/m^2 (40-49 years). Using ANOVA, the age-specific mean differences were observed to be statistically significant for males and females (in height, weight, and BMI). Age-sex specific mean differences in height, weight, and BMI were observed to be statistically insignificant (p>0.05). The age-specific differences were observed to be statistically significant in case of weight and BMI among males and females and only in case of mean height of females (Table 1).

Prevalence of Undernutrition and Overweight or Obesity

The overall prevalence of undernutrition and overweight or obesity is shown in Table 2. The overall prevalence of undernutrition was observed to be 22.86% (males: 18.68%; females: 26.05%). Age-specific prevalence of undernutrition was higher in the age groups of 20-29 years (29.11%) and 50-59 years (15.38%) among males. Among females, the prevalence of undernutrition was higher in the age groups of 50-59 years (37.78%) and 30-39 years (30.61%). The overall prevalence of overweight and obesity was observed to be 12.86% (males: 14.29%; females: 11.76%). Age-specific prevalence of overweight or obesity was higher among the age groups of 30-39 years (males: 25.00% and females: 16.33%) and 40-49 years (males: 22.22% and females: 20.45%) among males as well as among females. No age and sex-specific differences in the prevalence of undernutrition and overweight or obesity have been

Table 1. *Age and Gender Differences in Height, Weight, and BMI among the BMP*

Age (Years)	Sample size		Measurements and Index					
	M	F	Height (cm)		Weight (kg)		BMI (kg/m²)	
			Male	Female	Male	Female	Male	Female
20-29	79	100	165.46±7.56	153.40±6.47	55.03±7.01	47.65±7.24	20.15±2.58	20.35±2.88
30-39	28	49	163.94±5.53	154.09±5.05	60.61±8.69	49.94±8.04	22.60±3.42	21.13±3.85
40-49	36	44	162.53±6.12	152.36±7.57	58.49±11.21	53.13±10.36	22.12±3.90	22.82±3.63
50-59	39	45	163.48±7.68	150.49±6.15	57.17±9.47	45.34±9.22	21.39±3.34	19.95±3.45
Total	182	238	164.22±7.09	152.65±6.44	57.03±8.93	48.70±8.76	21.18±3.30	20.89±3.47
***F*-value**			1.67	2.71	3.26	7.28	5.80	7.01
***p*-value**			0.18	0.05	0.02	0.00	0.00	0.00

Table 2. *Prevalence of Undernutrition and Overweight or Obesity among the BMP Individuals*

Age (Years)	Sample size		Undernutrition (BMI<18.5 kg/m²)		Overweight or obesity (BMI ≥25 kg/m²)	
	Male	Female	Male	Female	Male	Female
20-29 years	79	100	23 (29.11)	27 (27.00)	7 (8.86)	7 (7.00)
30-39 years	28	49	2 (7.14)	15 (30.61)	7 (25.00)	8 (16.33)
40-49 years	36	44	3 (8.33)	3 (6.82)	8 (22.22)	9 (20.45)
50-59 years	39	45	6 (15.38)	17 (37.78)	4 (10.26)	4 (8.89)
Total	182	238	34 (18.68)	62 (26.05)	26 (14.29)	28 (11.76)

Values in parenthesis indicates percentage

observed using X^2-analysis.

Effect of Socio-economic, Demographic and Lifestyle Variables on Prevalence of Undernutrition and Overweight or Obesity

The differences in the prevalence of undernutrition and overweight with respect to the different socio-economic, demographic and lifestyle related variables are shown in Table 3. As noted earlier, a BLR model was fitted into the data to observe the odds ratio for the socio-economic, demographic and lifestyle-related variables to an individual being affected by undernutrition and overweight or obesity. In this BLR model, in case of every factor a reference category was selected and the result was determined by comparing the other factor with reference category. In case of undernutrition, the BLR analysis showed that individuals belonging to the lower age groups (18-39 years) have higher odds ratios (odds ratio: 1.65 times) with significantly higher risk of being undernourished ($p<0.05$). The occupation group of farmers and labourers were

Table 3. *Associations of Socio-economic, Demographic, and Lifestyle Related Variables with Undernutrition and Overweight or Obesity among the BMP*

Variables		Number of Individuals (N=420)	Undernourished (BMI<18.5 kg/m²) (N=96)	Undernutrition			Overweight or obesity (BMI≥25.00 kg/m²) (N=54)	Overweight or obesity		
				Wald	Odds	95%CI		Wald	Odds	95 %CI
Age (in years)	**18-39 years**	256	67 (69.79)	4.04	1.65*	1.01-2.69	29 (53.70)	1.36	1.41	0.79-2.50
	40-59 years	164	29 (30.21)	-	-	-	25 (46.30)	-	-	-
Sex	**Male**	182	34 (35.42)	-	-	-	26 (48.15)	0.58	1.25	0.71-2.22
	Female	238	62 (64.58)	3.15	1.53	0.96-2.46	28 (51.85)	-	-	-
Family Size	**2-4**	83	22 (22.92)	0.78	1.28	0.74-2.23	17 (31.48)*	5.20	2.09*	1.11-3.93
	5 and above	337	74 (77.08)	-	-	-	37 (68.52)*	-	-	-
Toilet Facility	**No**	96	24 (25.00)	0.32	1.17	0.69-1.98	15 (27.78)	-	-	-
	Yes	324	72 (75.00)	-	-	-	39 (72.22)	0.85	0.74	0.39-1.41
House Type	**Non-bricked**	308	45 (46.88)**	2.11	1.41	0.89-2.22	23 (42.59)**	-	-	-
	Bricked	112	51 (53.13)**	-	-	-	31 (57.41)**	0.12	0.91	0.51-1.61
Occupation	**Farmers and Labourers**	97	48 (50.00)**	45.28	5.61**	3.40-9.28	10 (18.52)	-	-	-
	Housewives and others	323	48 (50.00)**	-	-	-	44 (81.48)	0.73	1.37	0.66-2.84
Income (in rupees)	**≤4000**	66	18 (18.75)	0.86	1.33	0.73-2.41	7 (12.96)	-	-	-
	>4000	354	78 (81.25)	-	-	-	47 (87.04)	0.35	1.29	0.56-2.99

Values are parenthesis indicates percentage; **$p<0.01$;*$p<0.05$

observed to be at a statistically significant (p<0.01) higher risk of undernutrition (odds ratio: 5.61) than the group of housewives and others. Other variables did not show any significant associations with the prevalence of undernutrition. The χ^2 analysis showed statistically highly significant group differences in house type (non-bricked *vs.* bricked) (X^2-value=25.31) (p<0.01) and occupation (farmers and labours *vs.* housewives and others) (X^2-value=28.00) (p<0.01). In case of overweight or obesity, the BLR results showed that the individuals with less number of family members were at a significantly higher risk of overweight or obesity (odds ratio: 2.09 times) (p<0.05) and significant associations have been documented between family size and prevalence of overweight or obesity. Other variables did show statistically significant association with prevalence of overweight or obesity. The X^2-analysis showed statistically significant group differences in family size (2-4 family members *vs.* 5 and above family members) (X^2 -value= 3.95)(p<0.05) and house type (non-bricked *vs.* bricked) (X^2-value= 21.46) (p<0.01).

DISCUSSION

Prevalence of overweight or obesity has reached epidemic proportions globally. The rising prevalence of overnutrition in developing countries is largely due to rapid urbanization and changes in energy expenditure. Recent nutritional trend has shown that individuals/populations belonging to the developing countries were observed to be particularly vulnerable to obesity-related diseases in addition to comorbidities.[13,21,59,60,61] In India, there is an increasing trend of dual burden of malnutrition (both undernutrition and over-nutrition) which needs proper management to control the epidemic within populations. It also requires assessments and establishment of the socio-economic, educational, environmental and cultural factors involved in determining overweight or obesity within populations.[5,13,21,62,63,64] Majority of the Indian states have shown the prevalence of undernutrition among adults to varying between 20% and 29%.[65] Several studies have also reported high undernourishment among various Indian populations.[1,2,4,36,40,44] Recent studies have documented populations of the country to exhibit a high prevalence of overweight or obesity.[4,21,25,32] The prevalence of undernutrition is also a serious problem among the adult populations of East and Northeast India.[5,25,38,66,67-69] Therefore, the co-existence of the DBM (both under and overnutrition) is presenting a unique difficulty for public health policymakers. Nutrition transition have taken place in developing countries which led to the transition from undernutrition to overweight or obesity in populations.[33] Although, this type of transition may lead to the reduction of infectious diseases and mortality-morbidity associated with it but it may increase the burden to several preventable non-communicable and lifestyle diseases and incurred economic expenditures.

In the present investigation, utilizing the recent WHO[37] BMI reference, the prevalence of undernutrition (BMI<18.50 kg/m^2) was 22.86% and prevalence of combined overweight or obesity (BMI ≥25.00 kg/m^2) was 12.86% among the BMP (Table 2). A comparative evaluation of undernutrition (Figure 1) of different ethnic groups present in India as reported by different studies showed that the prevalence observed to be in the present investigation was lower than those reported for the Ahom (52.00%)[70], Koch (50.00%)[70], Bhatudi (64.50%)[45], Kora-Mudi (52.20%)[43], Savar (43.50%)[42], Oraon (49.60%)[36], Rajbanshi (42.00%) (North-Eastern India)[70], Dhimal (36.40%)[72], Lalung (34.69%)[70], Mishing/Miri (34.00%)[70], Santal (29.60%) (Odisha)[36], Rajbanshi (23.56%) (WB)[71], Santal (37.60%) (WB)[36] and Bhumij (28.20%) (WB and Odisha)[36] populations. The prevalence of undernutrition in the present investigation was observed to be higher than those reported among adults of Boro Kachari (11.22%)[70], Dibongiya (21.43%)[66], Mech (13.20%)[71] and Nyishi (10.50%)[69] populations. The comparative evaluation of overweight and obesity (Figure 2) of different ethnic groups present in India as reported by different studies showed that the prevalence observed in the present investigation was lower than those reported for Bengali Kayastha (80.00%)[29], Rengma Naga (43.34%)[5], Tangkhul Nagas of North-east India (27.10%)[25], Marwaris (25.91%)[27], Bengali Hindus (19.50%)[21], adults of Kash-

Figure 1: *Comparison of Undernutrition Prevalence Among Other Populations of India and the Present Investigation*[36,42,45,66,69-72]

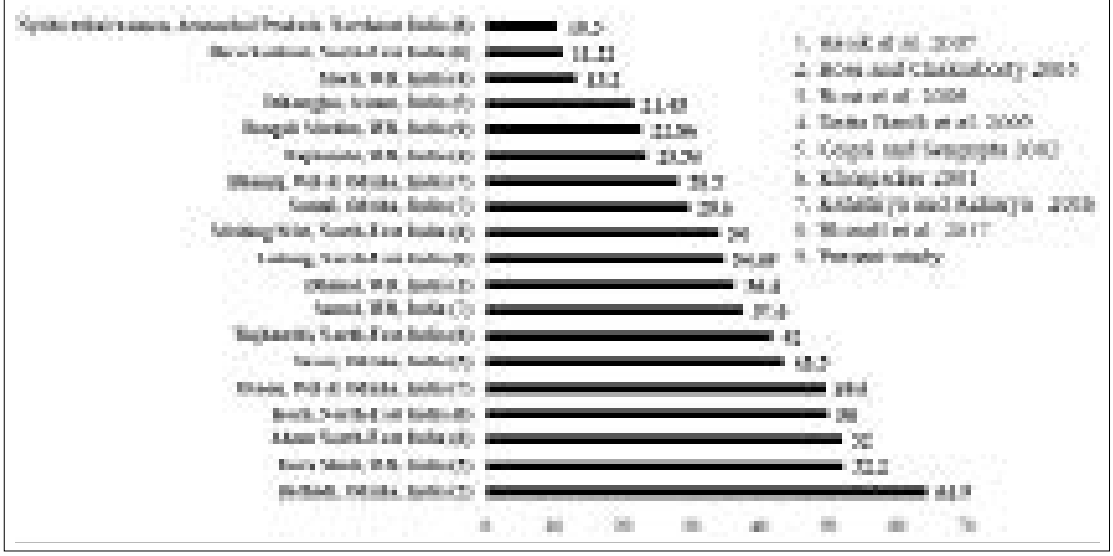
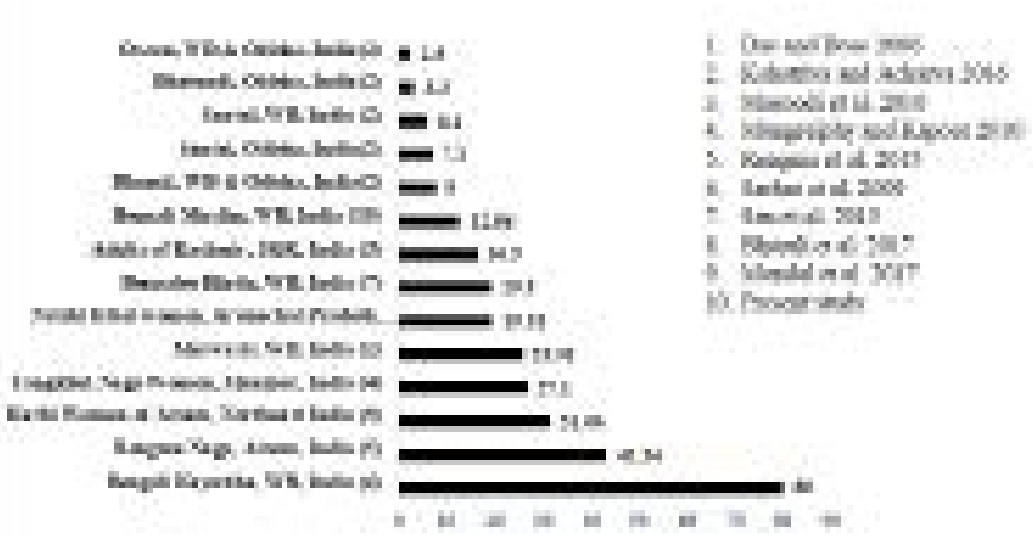


Figure 2: *Comparison of Overweight or Obesity Prevalence Among Other Populations of India and the Present Investigation*[5,13,19-21,25,36,69,73]



mir (16.30%)[73], Nyishi (19.51%)[69], and Karbi women (31.66%)[13] populations. The prevalence of overweight or obesity in the present investigation was observed to be higher than the adults belonging to Bhumij (8.00%), Santal of Odisha (7.10%), Santal of West Bengal (6.10%), Bhatundi (3.30%) and Oraon (2.50%) populations as reported by Kshatriya and Acharya.[36]

The present investigation has also observed that prevalence of undernutrition was higher among BMP females (26.05%) as compared to their male counterparts (18.68%). In case overweight or obesity the prevalence was observed to be slightly higher among the BMP males (14.28%) than the females (11.76%). Prevalence of undernutrition was observed to be higher in lower age groups (18-29 years) (p<0.05). Results of the BLR analysis showed a statistically significant association of undernutrition with the socio-economic variables viz., age and occupation of the individuals. Higher odds ratios have been observed for lower age groups (18-39 years) (odds ratio: 1.65; p<0.05) and in occupation group of Farmers and Labourers (odds ratio: 5.61; p<0.05). In case of overweight or obesity individuals with smaller family sizes (2-4 individuals) showed statistically significant association (odds ratio: 2.09; p<0.05). The prevalence of overweight or obesity was observed significantly associated with family size (p<0.05). Family size has been used to indicate how much proportion of resources are available for each person as increased family size or the increased number of individuals in a family may be a cause for competition for scarce resources. Therefore, rich families will have less competition and more resources while poor families will have fewer resources and more competition.

Associations of several socio-economic, demographic variables with the DBM (undernutrition and overweight or obesity) were already reported in the literature.[1,2,67,74,75] The present investigation has also observed associations of undernutrition and overweight or obesity with different socio-economic variables. However, these associations were not observed to be significant (p>0.05) in most of the cases as reported by other studies.[2,74,75] There were associations between some other socio-economic and demographic variables (e.g., sex, toilet facility and income) and the nutritional status of the studied population but these associations were not statistically significant (p>0.05). Presence or absence of toilets is an indicator of good hygiene and related to good health. However, the association of toilets was observed to be statistically not significant with prevalence of both undernutrition and overweight or obesity (Table 3).

Recent socio-economic and demographic transition which are taking place very rapidly leads to acceleration of several preventable, NCDs and higher prevalence of overweight or obesity and slightly lower prevalence of undernutrition among populations.[3,15,23,34] The present investigation observed higher prevalence of undernutrition and lower prevalence of overweight or obesity. According to, National Nutrition Monitoring Bureau (NNMB) (2005-2006) data, the combined prevalence of overweight and obesity was 7.80 and 10.90% among adult men and women (aged 18-59 years) in rural India, respectively.[76] National Family and Health Survey (NFHS)-3 and NFHS-4 data have clearly reflected that the overall nutritional status of the adult population with respect to chronic energy deficiency (CED) (BMI<18.5 kg/m^2) has declined among both males (34.20-20.20%) and females (35.50-22.90%). On the contrary, there has been an increase in the proportion of overweight or obese (BMI ≥25.00 kg/m^2) in males (9.30-18.60%) and females (12.60-20.70%).[77] The rise in household income has shifted the burden of overweight or obesity progressively from the wealthy to the poorer groups.[2] There are several factors such as socio-economic status, demographic conditions, diet, increasing sedentary lifestyle and decrease in physical activity) which have triggered the prevalence of overweight or obesity in populations.[2,13,25] Moreover, middle-aged individuals are more prone to being overweight and obese who mainly belongs to the higher socio-economic status and living in urban-affluent societies.[4,13,21] The results of the BLR analysis in the present investigation showed that only the family size of individuals is significantly associated with overweight or obesity. Other socio-economic and demographic

variables did not show any significant association with overweight obesity. On the other hand, age and occupation of individuals have shown significant association with undernutrition as observed in other studies.[2,21,25]

CONCLUSION

The findings of the present investigation suggest that even though undernutrition is still a cause for concern among the BMP there is also an existence of overweight and obesity. This establishes the existence of the DBM and the greater magnitude of undernutrition and overweight or obesity among the BMP. This observation was also similar to the findings of recent studies of Indian adult population. This suggests necessary nutritional interventions in the population concerned. The limitation of the present investigation is that the present investigation did not observe significant associations of many socio-economic factors as observed in other similar studies. The results in the present investigation might be helpful to the Government agencies and policy makers to formulate appropriate strategies such as organising regular health check-up camps to identify the health problems among the individuals due to undernutrition and overweight or obesity and also to carry out proper dissemination of knowledge about healthy diet, healthy lifestyle, and food supplementation for the overall improvement of the health status of the BMP.

CONFLICTS OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

REFERENCES

1. 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: 633-640. doi: 10.1093/ajcn/84.3.633

2. Subramanian SV, Kawachi I, Smith GD. Income inequality and the double burden of under- and overnutrition in India. *J Epidemiol Comm Health.* 2007; 61: 802-809. doi: 10.1136/jech.2006.053801

3. 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: 456-474. doi: 10.1111/j.1467-789X.2009.00568.x

4. 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: 618-638. doi: 10.1080/03670244.2014.891994

5. Rengma MS, Sen J, Mondal N. Socio-economic, demographic and lifestyle determinants of overweight and obesity among adults of Northeast India. *Ethiop J Health Sci.* 2015; 25: 199-208.

6. Bhutia DT. Protein energy malnutrition in India: The plight of our under five children. *J Fam Med Pri Care.* 2014; 3: 63-67. doi: 10.4103/2249-4863.130279

7. Jain S. Food security in India: Problems and prospects. *OIDA International Journal of Sustainable Development.* 2016; 9: 11-20.

8. Mishra CP. Malnutrition-free India: Dream or reality. *Indian J Pub Health.* 2017; 61: 155. doi: 10.4103/ijph.IJPH_217_17

9. Popkin BM. Nutrition in transition: The changing global nutrition challenge. *Asia Pac J Clin Nutr.* 2001; 10: S13-S18.

10. Popkin BM. The shift in stages of the nutrition transition in the developing world differs from past experiences!. *Pub Health Nutr.* 2002; 5: 205-214. doi: 10.1079/PHN2001295

11. Kapoor SK, Anand K. Nutritional transition: A public health challenge in developing countries; 2002.

12. Kapil U, Sachdev HP. Urgent need to orient public health response to rapid nutrition transition. *Ind J Comm Med: Off Pub Ind Ass Prev Soc Med.* 2012; 37: 207. doi: 10.4103/0970-0218.103465

13. Mondal N, Timungpi R, Sen J, Bose K. Socio-economic and demographic correlates of overweight and obesity: A study on the Karbi women of Assam, Northeast India. *Anthropol Open J.* 2017; 2: 31-39. doi: 10.17140/ANTPOJ-2-111

14. Som S, Pal M, Bharati P. Role of individual and household level factors on stunting: A comparative study in three Indian states. *Ann Hum Biol.* 2007; 34: 632-646. doi: 10.1080/03014460701671772

15. Varadharajan KS, Thomas T, Kurpad AV. Poverty and the state of nutrition in India. *Asia Pac J Clin Nutr.* 2013; 22: 326-339. doi: 10.6133/apjcn.2013.22.3.19

16. Debnath S, Mondal N, Sen J. Use of upper arm anthropometry, upper arm muscle area-by-height (UAMAH) and midupper-arm-circumference (MUAC)-for-height as indicators of body composition and nutritional status among children. *Anthropol Rev.* 2017; 80: 85-102. doi: 10.1515/anre-2017-0004

17. Dudeja V, Misra A, Pandey RM, Devina G, Kumar G, Vikram NK. BMI does not accurately predict overweight in Asian Indians in northern India. *Br J Nutr.* 2001; 86: 105-112. doi: 10.1079/BJN2001382

18. Bhadra MA, Mukhopadhyay A, Bose K. Overweight and obesity among adult Bengalee Hindu Women of Kolkata India. *Hum Ecol.* 2005; 13: 77-83.

19. Das M, Bose K. Presence of high rates of overweight and obesity among adult Marwaris of Howrah, West Bengal, India. *Coll Antropol.* 2006; 30: 81-86.

20. Sarkar D, Mondal N, Sen J. Obesity and blood pressure variations among the Bengali Kayastha Population of North Bengal, India. *J Life Sci.* 2009; 1: 35-43. doi: 10.1080/09751270.2009.11885132

21. Sen J, Mondal N, Dutta S. Factors affecting overweight and obesity among urban adults: A cross-sectional study. *Epidemiol Biostat Pub Health.* 2013; 10: e8741–1-8. doi: 10.2427/8741

22. Kulkarni VS, Kulkarni VS, Gaiha R. Double burden of malnutrition: Re-examining the coexistence of undernutrition and overweight among Women in India. *Int J Health Serv.* 2017; 47: 108-133. doi: 10.1177/0020731416664666

23. Subramanian SV, Corsi DJ, Subramanyam MA, Smith GD. Jumping the gun: The problematic discourse on socioeconomic status and cardiovascular health in India. *Int J Epidemiol.* 2013; 42: 1410-1426. doi: 10.1093/ije/dyt017

24. De R, Kundu JK. Nutritional status of adult female tribes in different villages of Jhargram, West Bengal. *World J Pharma Pharmac Sci.* 2016; 5: 1213-1220.

25. Mungreiphy NK, Kapoor S. Socioeconomic changes as covariates of overweight and obesity among Tangkhul Naga tribal women of Manipur, north-east India. *J Biosoc Sci.* 2010; 42: 289-305. doi: 10.1017/S0021932009990587

26. Sen J, Mondal N, Dey S. Assessment of the nutritional status of children aged 5-12 years using upper arm composition. *Ann Hum Biol.*2011; 38: 752-759. doi: 10.3109/03014460.2011.610358

27. Das S, Bose K. Nutritional assessment by mid-upper arm circumference of Santal adults of Purulia, West Bengal, India. *Coll Antropol.* 2012; 36: 581-584.

28. Patil YP, Shinde RL. Undernutrition among Indian men: A study based on NFHS-3. *Am J Mens Health.* 2014; 8: 492-502. doi: 10.1177/1557988314525193

29. Kalaiselvi S, Arjumand Y, Jayalakshmy R, Gomathi R, Pruthu T, Palanivel C. Prevalence of under-nutrition, associated factors and perceived nutritional status among elderly in a rural area of Puducherry, South India. *Arch Gerontol Geriatr.* 2016; 65: 156-160. doi: 10.1016/j.archger.2016.03.003

30. Faizi N, Khan Z, Khan IM, Amir A, Azmi SA, Khalique N. A study on nutritional status of school-going adolescents in Aligarh, India. *Trop Doct.* 2017; 47: 212-216. doi: 10.1177/0049475516668985

31. Shukla HC, Gupta PC, Mehta HC, Hébert JR. Descriptive epidemiology of body mass index of an urban adult population in western India. *J Epidemiol Comm Health.* 2002; 56: 876-880. doi: 10.1136/jech.56.11.876

32. Girdhar S, Sharma S, Chaudhary A, Bansal P, Satija M. An epidemiological study of overweight and obesity among women in an Urban Area of North India. *Ind J Comm Med.* 2016; 41: 154-157. doi: 10.4103/0970-0218.173492

33. Jaiswal M, Bansal R, Agarwal A. Role of mid-upper arm circumference for determining overweight and obesity in children and adolescents. *J Clin Diagn Res.* 2017; 11: SC05-SC08. doi: 10.7860/JCDR/2017/27442.10422

34. Popkin BM, Adair LS, Ng SW. Global nutrition transition and the pandemic of obesity in developing countries. *Nutr Rev.* 2012; 70: 3-21. doi: 10.1111/j.1753-4887.2011.00456.x

35. Ghosh P, Mondal N, Sen J. Evidence of a double burden of malnutrition among Rajbanshi adolescent boys. *South Asian Anthropol.* 2014; 14: 81-88.

36. Kshatriya GK, Acharya SK. Gender disparities in the prevalence of undernutrition and the higher risk among the young women of Indian tribes. *PLoS One.* 2016; 11: e0158308. doi: 10.1371/journal.pone.0158308

37. World Health Organization (WHO). Physical Status: The use and interpretation of anthropometry. Technical Report Series No. 854. Geneva: *World Health Organization;* 1995.

38. Khongsdier R. Body mass index and morbidity in adult males of the War Khasi in Northeast India. *Eur J Clin Nutr.* 2002; 56: 484. doi: 10.1038/sj.ejcn.1601281

39. Rao KM, Kumar RH, Venkaiah K, Brahmam GNV. Nutritional status of saharia – A primitive tribe of Rajasthan. *J Hum Ecol.* 2006; 19: 117-123.

40. Bharati S, Pal M, Bhattacharya BM, Bharati P. Prevalence and causes of chronic energy deficiency and obesity in Indian women. *Hum Biol.* 2007; 79: 395-412. doi: 10.1353/hub.2007.0048

41. Griffiths PL, Bentley ME. The nutrition transition is underway in India. *Nutr.* 2001; 131: 2692-2700. doi: 10.1093/jn/131.10.2692

42. Bose K, Chakraborty F, Bisai S, Khatun A, Bauri H. Body mass index and nutritional status of adult Savartribals of Keonjhar District, Orissa, India. *Asia Pac J Pub Health.* 2006; 18: 3-7. doi: 10.1177/10105395060180030201

43. Bose K, Ganguli S, Mamtaz H, Mukhopadhyay A, Bhadra M. High prevalence of undernutrition among adult Kora Mudi tribals of Bankura District, West Bengal, India. *Anthro Sci.* 2006; 114: 65-68. doi: 10.1537/ase.050306

44. Datta Banik S. Nutritional status adiposity and body composition of Oraon and Sarak females in Ranchi District, India--a comparison. *Ecol Food Nutr.* 2011; 50: 43-62. doi: 10.1080/03670244.2011.539160

45. Bose K, Chakraborty F. Anthropometric characteristics and nutritional status based on body mass index of adult Bathudis: A tribal population of Keonjhar District, Orissa, India. *Asia Pac J Clin Nutr.* 2005; 14: 80-82.

46. Gouda J, Prusty RK. Overweight and obesity among women by economic stratum in urban India. *J Health Pop Nutr.* 2014; 32: 79-88.

47. Banik SD, Ghosh M, Bose K. Anthropometric and body frame size characteristics in relation to body mass index and percentage body fat among adult Bengalee male brick-kiln workers from Murshidabad, West Bengal, India. *Anthropol Anz.* 2016; 73: 313-321. doi: 10.1127/anthranz/2016/0644

48. Sudar A. Body fatness and its social and lifestyle determinants in young working males from Cracow, Poland. *J Biosoc Sci.* 2009; 41: 139-154. doi: 10.1017/S0021932008002873

49. Garg C, Khan SA, Ansari SH, Garg M. Prevalence of obesity in Indian women. *Obesity Rev.*2010; 11: 105-108. doi: 10.1111/j.1467-789X.2009.00666.x

50. Kar NB, Ghosh BN. Education and Socio-economic Marginalization of Muslim Women: A case study of North 24-Parganas District in West Bengal. *Bangladesh e-J Soc.* 2017; 14.

51. Das Chaudhuri AB, Basu S, Chakraborty S. Twinning rate in the Muslim population of West Bengal. *Acta Genet Med Gemellol (Roma).*1993; 42: 35-39. doi: 10.1017/S0515283600042268

52. Lwanga SK, Lemeshow S. Sample size determination in health studies: A Practical Manual. Geneva: World Health Organization; 1991.

53. Touitou Y, Portaluppi F, Smolensky MH, Rensing L. Ethical principles and standards for the conduct of human and animal biological rhythm research. *Chronobiol Int.* 2004; 21: 161-170. doi: 10.1081/CBI-120030045

54. Hall J, Allanson J, Gripp K, Slavotinek A. *Handbook of Physical Measurements*. New York, USA: Oxford University Press; 2007.

55. Harris EF, Smith RN. Accounting for measurement error: A critical but often overlooked process. *Arch Oral Biol.* 2009; 54: S107-S117. doi: 10.1016/j.archoralbio.2008.04.010

56. Ulijaszek SJ, Kerr DA. Anthropometric measurement error and the assessment of nutritional status. *Brit J Nutr.* 1999; 82: 165-177. doi: 10.1017/S0007114599001348

57. Mishra D, Singh HP. Kuppuswami's socio-economic status scale – A revision. *Ind J Pediatr.* 2003; 70: 273-274. doi: 10.1007/s12098-016-2223-y

58. Kumar N, Shekhar C, Kumar P, Kundu AS. Kuppuswamy's socioeconomic status scale-updating for 2007. *Ind J Pediatr.* 2007; 74: 1131-1132.

59. Bhurosy T, Jeewon R. Overweight and obesity epidemic in developing countries: A problem with diet, physical activity, or socioeconomic status?. *Sci World J.* 2014. doi: 10.1155/2014/964236

60. Jésus P, Maëlenn G, Sophie P, et al. Undernutrition and obesity among elderly people living in two cities of developing countries: Prevalence and associated factors in the EDAC study. *Clin Nutr ESPEN.* 2017; 21: 40-50. doi: 10.1016/j.clnesp.2017.05.007

61. Tremmel M, Gerdtham UG, Nilsson PM, Saha S. Economic burden of obesity: A systematic literature review. *Int J Environ Res Pub Health.* 2017; 14: 435. doi: 10.3390/ijerph14040435

62. Biernat E, Tomaszewski P. Association of socio-economic and demographic factors with physical activity of males and females aged 20-69 years. *Ann Agri Env Med.* 2015; 22. doi: 10.5604/12321966.1141380

63. Bagordo F, De Donno A, Grassi T, et al. Lifestyles and socio-cultural factors among children aged 6-8 years from five Italian towns: The MAPEC_LIFE study cohort. *BMC Pub Health.* 2017; 17: 233. doi: 10.1186/s12889-017-4142-x

64. Nienaber-Rousseau C, Sotunde OF, Ukegbu PO, et al. Socio-demographic and lifestyle factors predict 5-year changes in adiposity among a group of black South African adults. *Int J Env Res Pub Health.* 2017; 14: 1089. doi: 10.3390/ijerph14091089

65. Ramachandran N. *Persisting Under-nutrition in India.* India: Springer; 2014.

66. Gogoi G, Sengupta S. Body Mass Index among the Dibongiya Deoris of Assam, India. *J Hum Ecol.* 2002; 13: 271-273. doi: 10.1080/09709274.2002.11905544

67. Tigga PL, Sen J, Mondal N. Association of some socio-economic and socio-demographic variables with wasting among preschool children of North Bengal, India. *Ethiop J Health Sci.* 2015; 25: 63-72.

68. Singh KD, Alagarajan M, Ladusingh L. What explains child malnutrition of indigenous people of northeast india? *PLoS One.* 2015; 10: e0130567. doi: 10.1371/journal.pone.0130567

69. Bharali N, Mondal N, Singh KN. Prevalence of undernutrition. overweight and obesity among. *Hum Biol Rev.* 2017; 6: 63-78.

70. Khongsdier R. Body mass index of adult males in 12 populations of Northeast India. *Ann Hum Biol.* 2001; 28: 374-383. doi: 10.1080/03014460010004610

71. Datta Banik S, Bhattacharjee P, Das S, et al. Sexual dimorphism in health and nutritional status of three communities of Darjeeling District in West Bengal and comparison with some other populations of eastern India: An anthropometric appraisal. *J Life Sci.* 2009; 1: 27-34. doi: 10.1080/09751270.2009.11885131

72. Datta Banik S, Bose K, Bisai S, Bhattacharya M, Das S, Jana A, Purkait P. Undernutrition among adult Dhimals of Naxalbari, West Bengal: Comparison with other tribes of eastern India. *Food Nutr Bull.* 2007; 28: 348-352. doi: 10.1177/156482650702800311

73. Masoodi SR, Wani AA, Wani AI, Bashir MI, Laway BA, Zargar AH. Prevalence of overweight and obesity in young adults aged 20-40 years in North India (Kashmir Valley). *Diabetes Res Clin Pract.* 2010; 87: e4-e6. doi: 10.1016/j.diabres.2009.11.004

74. Sen J, Roy A, Mondal N. Association of maternal nutritional status, body composition and socio-economic variables with low birth weight in India. *J Trop Paediatr.* 2009; 56: 254-259. doi: 10.1093/tropej/fmp102

75. Venkatramanan S, Marquis GS, Haas JD. Ethnicity and socioeconomic factors are associated with poor nutritional status in female tea plantation workers from rural India. *FASEB J.* 2017; 31: 637-639. doi: 10.1096/fasebj.31.1_supplement.639.37

76. National Nutrition Monitoring Bureau (NNMB). Diet and nutritional status of population and prevalence of hypertension amongst adults in rural areas. *Nat Nutr Monitor Bureau Tech Report No*: 24. 2007.

77. Mishra CP. Malnutrition-free India: Dream or reality. *Indian J Pub Health.* 2017; 61: 155. doi: 10.4103/ijph.IJPH_217_17