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Prediction of Socioeconomic Factors Affecting on Double Burden of Malnutrition among Rural Adult Bengali: A Cross-Sectional Study in Birbhum District of West Bengal

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ABSTRACT:
Objective: The present study intends to find out socioeconomic determinants of undernutrition and overnutrition among adult Bengali males and females in West Bengal.
Materials and Methods: A cross-sectional study was conducted on 7538 Bengalis aged 18 to 75 years, with 3762 males and 3776 females. The research was carried out in two blocks named Bolpur Sriniketan and Sainthia of Birbhum. Study area and participants were selected through simple random sampling (SRS) technique. Anthropometric measures were taken, and nutritional indicators such as Body Mass Index (BMI), Waist Hip Ratio (WHR), and Waist Height Ratio (WHtR) were calculated. Some socioeconomic data were collected based on National Family Health Survey guidelines (NFHS, 2015), to explore how they influenced nutritional status.
Results: Undernutrition rate was highest among middle-aged males (39.39%) and elderly females (36.24%). Elderly had highest rates of central obesity (WHtR), with 39.67% males and 52.71% females. Age had a significant positive association with BMI, WHR, and WHtR (r-value, $p<0.05$). Multinomial logistics regression (MLR) revealed that socioeconomic variables had an impact on nutritional status. Based on MLR of both sexes, significant and common factors were age, wealth index, and monthly family income for undernutrition, while monthly family income for overnutrition.
Conclusion: The coexistence of the double burden of malnutrition and socioeconomic factors was found. Females were shown to be more prone to overnutrition than males. Nutritional disparities and economic inequality exist together and this economic inequality was a major factor affecting the double burden of malnutrition of Bengalee adults in Birbhum.

Keywords: *Undernutrition, Overnutrition, Developing country, Bengali, West Bengal*

INTRODUCTION:

Developing countries are experiencing a nutritional transition with the coexistence of undernutrition and overnutrition problems (Malik et al., 2018). Studies have shown that Indian adults are suffering from double burden of malnutrition, such as undernutrition or chronic energy deficiency (CED) and overnutrition or obesity (Dutta et al., 2019; Gopalan, 2013). Now it is becoming a serious public health concern worldwide, as such nutritional transitions have been reported in Latin America, South Asia, Southeast Asia, Eastern Europe and Africa (Duran et al., 2006; Dutta et al., 2019; Doak et al., 2005, Gkiouras et al., 2020; Min et al., 2018; Jones et al., 2016; Acharya et al., 2020).

Double burden of malnutrition has appeared across all types of socioeconomic groups (Kaku & Patil, 2020). Changes in dietary consumption and lifestyle lead to changes in people's nutritional profiles. A number of factors, including economic, demographic, environmental, social, and cultural factors, contribute to these trends (Popkin, 1993). Evidence from developing countries shows that undernutrition primarily affects the poor, whereas overnutrition affects those in better socioeconomic categories (Kulkarni et al., 2016). But the study by Little et al. (2020) suggests that rural Indian women are particularly at risk of double burden of malnutrition on an individual level.

Undernutrition and overnutrition both have a detrimental impact on health and are leading causes of mortality. Obesity-related cardiovascular diseases (CVD) are becoming a serious public health concern in India, NFHS-4 reported that 13.6% of males and 8.8% of females are suffering from high blood pressure or hypertension in India (NFHS-4, 2017). In India 57% of all stroke deaths and 24% of all coronary heart disease (CHD) deaths take place for hypertension (Gupta, 2004). Overnutrition is associated with diabetes (Hossain et al., 2007), and in India 8% of males and 5.8% of females have blood sugar level >140 mg/dl (NFHS-4, 2017).

Meanwhile, despite rapid economic development and associated dietary and lifestyle changes, various parts of India are poor, have food insecurity, and have limited access to healthcare, all of which contribute to the never-ending problem of malnutrition and related deficits (Little et al., 2020). Underweight is linked with an increased risk of premature mortality, disability, sexual and mental immaturity, poor self-determined health and well-being, particularly in developing countries (Rytter et al., 2014; Cameron & Bogin, 2012).

The double burden of malnutrition differs considerably by gender, socioeconomic and lifestyle factors. Socioeconomic variables such as residential regions (urban and rural), income, and level of education of mother and head of the family are most common determinants of malnutrition (Kosaka & Umezaki, 2017). Economic conditions, particularly in developing nations, have emerged as a significant predictor of obesity (Selvamani & Singh, 2018; Gouda & Prusty, 2014). Adults who are less educated and deprived, are more likely to be underweight (Subramanian et al., 2009). In this context, the present study intends to find out socioeconomic determinants of undernutrition and overnutrition among adult Bengali males and females in West Bengal.

MATERIALS AND METHODS:

A cross-sectional study was conducted among adult males and females, aged 18 to 75 years, during June 2019 to December 2019. Participants were selected on the basis of their dialect – only the Bengali-speaking population was selected for the study. The study considers those people who have been residing there at least for four generations. Data were collected from both tribal and non-tribal people; tribal people belonged to the Santal community and non-tribals were from Hindu and Muslim religions.

Sampling: area and participants

The study was conducted in the two blocks, namely, Bolpur Sriniketan and Sainthia in the Birbhum district of the State of West Bengal in India. There are 156 villages in Bolpur Sriniketan Block and 216 villages in Sainthia Block (Census of India, 2011). From the list of villages, 25 villages in Bolpur Sriniketan Block and 23 villages in Sainthia Block were selected through Simple Random Sampling (SRS) technique. From each of the selected villages again SRS technique was used to select the households. A single couple and their unmarried offspring were selected for the study. From each selected household, a single couple and their unmarried offspring were selected for the study. The sample size was 7538, of which 3762 were males and 3776 were females. This study included rural and peri-urban settlements.

Data collection procedures

The trained investigators collected data from the respondents in the selected households using a pretested schedule. Anthropometric measurements, based on the guideline of Weiner and Lourie (1981), and Frisancho (2011) (Weiner and Lourie 1981; Frisancho 2011), were also taken of participants. Body height (in cm) was measured by anthropometer

(on nearest ±0.1 cm), and body mass or weight (in kg) was measured by a reliable portable weighing scale (on nearest ±0.1 kg). Waist circumference (in cm) and hip circumference (in cm) were measured by an inelastic tape (on nearest ±0.1 cm). Age of the participants was confirmed on the basis of birth certificate. For those who did not have a birth certificate, the school certificate, Voter ID card or Aadhaar card was carefully considered as a secondary source.

Socioeconomic data were collected on the basis of National Family Health Survey guidelines (NFHS, 2015), and data consisted of monthly family income (in Rupees), highest educational qualification, earning activities, religion, caste, house type as floor wall and roof material separately, sanitary system, drinking water source, cooking fuel materials, household assets, etc. Wealth index was calculated on the basis of drinking water, type of house, type of fuel materials used for cooking, sanitation and household assets through principal components analysis (PCA) guidelines.

Indicators of undernutrition and overnutrition

Body mass index (BMI) was calculated as, weight in kilogram divided by square of height in meter (kg/m^2). Regional fat distribution was estimated on the basis of Waist Hip Ratio (WHR) and central obesity was estimated based on Waist Height Ratio (WHtR). BMI was categorized according to the WHO (2004) recommended cutoffs, where a person with BMI <18.5 was categorized as underweight, BMI ≥18 but 25 was categorized as normal, BMI ≥ 25 but < 30 was categorized as overweight (grade-1 obese), BMI ≥ 30 but < 40 was categorized as obese (grade-2 obesity) and lastly BMI ≥ 40 was categorized as morbid obese (grade-3 obesity), so ≥ 25 Kg/m^2 was considered as overnutrition in this study. The most popular WHR cutoffs provided by WHO (2011) considered as obese if WHR ≥ 0.90 for male, and ≥ 0.85 for female. WHtR ≥ 0.50 was used as the cutoff value for obesity in both male and female (Ashwell & Hsieh, 2005).

Statistical analysis

Data were analyzed by using the Statistical Package for the Social Sciences (SPSS, version 25.0). Both descriptive and inferential statistical analyses were applied in this study. Mean, standard division (SD) and percentages were considered in the descriptive statistics analysis. Analysis of variance (ANOVA), t-test, and multinomial logistic regression were carried out, which were parametric methods; and chi-square test (χ^2) was used as non-

parametric method. Significant levels for all these analyses were considered as $p < 0.05$ and $p < 0.01$. The regressors were tested for the existence of multicollinearity. The regressors with high Variance Inflation Factor (VIF) were excluded. The participants were divided into three age groups as, 18 to 40 years for young adults, > 40 to 60 years for middle-aged adults, and > 60 to 75 as elderly adults.

RESULTS:

Distribution of Nutritional Status as per age group

Upto the age of 60 years, all nutritional indicators were significantly (t-value, $p<0.01$) different between male and female. In the case of above 60 years, hip circumference and BMI were not significantly different as per t-test (Table 1a). Comparatively higher mean values were found in males, except hip circumference as expected. Mean BMI for both sexes belonged to the normal level, but relatively higher mean value was found among females. However, ANOVA shows that a significant (F value, $p<0.01$) difference exists for each nutritional indicator in respect of age groups, except weight in males (Table 1b).

Table 1a: Difference of mean (SD) between male and female among the age groups

Nutritional indicators	18-40 year			>40-60 year			>60-75 year		
	Male	Female	t-value	Male	Female	t-value	Male	Female	t-value
Height (cm)	164.25 (6.78)	151.02 (5.96)	63.24**	162.48 (6.78)	150.13 (5.96)	52.68**	161.99 (7.29)	147.77 (5.95)	31.16**
Weight (kg)	53.46 (10.42)	47.27 (9.96)	18.53**	54.08 (10.59)	48.23 (9.97)	15.47**	52.81 (11.63)	44.79 (10.44)	10.57**
Waist cir. (cm)	73.27 (9.62)	72.10 (11.41)	3.38**	78.45 (10.49)	76.07 (11.46)	5.89**	79.16 (12.34)	75.99 (12.65)	3.70**
Hip cir. (cm)	82.43 (6.90)	83.77 (8.03)	5.45**	83.25 (6.88)	84.78 (7.93)	5.61**	83.07 (7.51)	82.77 (8.48)	0.54
BMI	19.74 (3.19)	20.67 (3.91)	7.96**	20.40 (3.32)	21.33 (3.91)	6.98**	20.01 (3.61)	20.44 (4.26)	1.60
WHR	0.89 (0.06)	0.86 (0.08)	12.04**	0.94 (0.07)	0.89 (0.08)	15.66**	0.95 (0.09)	0.91 (0.09)	5.65**
WHtR	0.45 (0.06)	0.48 (0.07)	14.76**	0.48 (0.06)	0.51 (0.07)	9.70**	0.49 (0.07)	0.51 (0.08)	4.96**

Significant **p<0.01; cir. = circumference

1B. Differences of mean within the age groups (18-40 year, >40-60 year, &>60-75 year)

Nutritional indicators	Male		Female	
	F-value	p-value	F-value	p-value
Height (cm)	36.26	0.00	52.74	0.00
Weight (kg)	2.82	0.06	19.63	0.00
Waist circumference (cm)	127.09	0.00	55.02	0.00
Hip circumference (cm)	6.03	0.00	12.73	0.00
BMI	16.55	0.00	14.96	0.00
WHR	290.32	0.00	123.91	0.00
WHtR	195.32	0.00	83.08	0.00

Both types of malnutrition, i.e., undernutrition (underweight - UW) and overnutrition (overweight and obesity – OW/O) were profound in case of BMI classification among the participants (Table 2a). Percentage of undernutrition was higher in male, maximum (39.39%) found in middle-aged group; among the female it was maximum (36.24%) in final-aged group, whereas percentage of overnutrition was higher in middle-aged group for both sexes, male (9.94%) and female (17.50%). So far related to BMI, frequency of males and females in each category significantly (Chi-square, $p<0.05$) differed for each age group. Waist-hip ratio (WHR) and waist-height ratio (WHtR) both indicate that percentage of obesity simultaneously increased with the increase of age. In the younger age group male and female significantly (Chi-square value, $p<0.01$) differed as per WHR classification, and after 40 years no significant difference was observed. Male and female frequencies were significantly different for each age group, according to the WHtR classification.

Table 2a: Frequency distribution of nutritional status based on BMI, WHR and WHtR category

	18-40 year		>40-60 year		>60-75 year	
BMI category	Male, n(%)	Female, n(%)	Male, n(%)	Female, n(%)	Male, n(%)	Female, n(%)
Underweight	735 (39.39)	609 (32.74)	464 (31.56)	376 (25.22)	162 (38.03)	154 (36.24)
Normal	993 (53.22)	979 (52.63)	860 (58.50)	854 (57.28)	226 (53.05)	204 (48.00)
Overweight	126 (6.75)	233 (12.53)	139 (9.46)	227 (15.22)	35 (8.22)	59 (13.88)
Obese	12 (0.64)	39 (2.10)	7 (0.48)	34 (2.28)	3 (0.70)	8 (1.88)
Chi-square	58.09**		48.03**		9.73*	
WHR category						
Normal	1048 (56.16)	847 (45.54)	399 (27.14)	431 (28.91)	114 (26.76)	96 (22.59)
Obese	818 (43.84)	1013 (54.46)	1071 (72.86)	1060 (71.09)	312 (73.24)	329 (77.41)
Chi-square	42.08**		1.14		1.99	
WHtR category						
Normal	1588 (85.10)	1250 (67.20)	957 (65.10)	741 (49.70)	257 (60.33)	201 (47.29)
Obese	278 (14.90)	610 (32.80)	513 (34.90)	750 (50.30)	169 (39.67)	224 (52.71)
Chi-square	164.37**		71.80**		14.54**	

Significant ** $p<0.01$, *$p<0.05$

However, derived nutritional indicators (BMI, WHR, and WHtR) and age of the participants have shown significant (r-value, $p<0.01$) and positive correlation (Table 2b). Significant but poor correlation was observed in BMI with age in both sexes (r - 0.095, $p<0.01$) compared to WHR (r - 0.334, $p<0.01$) and WHtR (r - 0.296,

2b. Correlation between age and nutritional indicators

Nutritional Indicators	Male	Female	Both (M&F)
Height (cm)	-0.135**	-0.176**	-0.120**
Weight (kg)	0.040*	0.007	0.019
Waist circumference (cm)	0.301**	0.202**	0.247**
Hip circumference (cm)	0.087**	0.044**	0.065**
BMI	0.113**	0.078**	0.095**
WHR	0.415**	0.284**	0.334**
WHtR	0.357**	0.253**	0.296**

Significant ** $p<0.01$, * $p<0.05$

p<0.01). Still, there is no doubt that the higher levels of these indicators indicate obesity, which increased with age.

Association between socioeconomic factors and nutritional status

Table 3: Distribution of socioeconomic variables

Socioeconomic variables	Male (n = 3762)		Female (n = 3776)		Total (n = 7538)	
	n	%	n	%	n	%
Wealth index (WI)						
wi1 - Lower	341	9.1	394	10.5	735	9.7
wi2 - Lower Middle	643	17.1	635	16.8	1278	17.0
wi3 - Middle	650	17.3	632	16.7	1282	17.0
wi4 - Upper Middle	1020	27.1	1035	27.4	2055	27.3
wi5 - Upper	1108	29.4	1080	28.6	2188	29.0
Earning activity (EA)						
ea1 - Wage earner/labour	1875	49.8	1850	49.0	3725	49.4
ea2 - Agriculture	331	8.8	320	8.5	651	8.6
ea3 - Business/petty-trade	546	14.6	504	13.3	1050	13.9
ea4 - Formal sector /salaried service	467	12.4	490	13.0	957	12.8
ea5 - Self-employment	262	7.0	245	6.5	507	6.7
ea6 - Pension	238	6.3	273	7.2	511	6.8
ea7 - Other	43	1.1	94	2.5	137	1.8
Monthly family income – INR (MI)						
mi1 - <5000	1344	35.7	1472	39.0	2816	37.4
mi2 - 5000-7500	1106	29.4	1018	27.0	2124	28.2
mi3 - 7501-10000	478	12.7	443	11.7	921	12.2
mi4 - 10001-15000	355	9.4	355	9.4	710	9.4
mi5 - 15001-30000	365	9.8	375	9.9	740	9.8
mi6 - >30000	114	3.0	113	3.0	227	3.0
Education – (E)						
e1 - Non-literate	889	23.6	1547	41.0	2436	32.3
e2 – Primary	501	13.3	511	13.5	1012	13.4
e3 – Secondary	1440	38.3	1265	33.5	2705	35.9
e4 - Upto UG	854	22.7	417	11.0	1271	16.9
e5 - Beyond UG	78	2.1	36	1.0	114	1.5
Floor type – House(FT)						
ft1 - Mud	1474	39.2	1458	38.6	2932	38.9
ft2 - Semi-pucca	143	3.8	159	4.2	302	4.0
ft3 - Pucca	2145	57.0	2159	57.2	4304	57.1
Roof type – House (RT)						
rt1 - Straw &roof tiles	849	22.6	850	22.5	1699	22.5
rt2 - Pucca	1524	40.5	1551	41.1	3075	40.8
rt3 - Metal roof sheets& asbestos	1389	36.9	1375	36.4	2764	36.7
Wall type – House (WT)						
wt1 - Mud	1495	39.8	1464	38.8	2959	39.3
wt2 - Semi-pucca	468	12.4	486	12.8	954	12.6
wt3 - Pucca	1799	47.8	1826	48.4	3625	48.1
Caste (C)						
c1 - General	1611	42.8	1691	44.8	3302	43.8
c2 - Other backward classes	477	12.7	438	11.6	915	12.1
c3 - Scheduled caste	1513	40.2	1472	39.0	2985	39.6
c4 - Scheduled tribe	161	4.3	175	4.6	336	4.5

Table 3 shows the percentage distribution of the categories under various socioeconomic factors separately for the male and female participants. The number of participants was approximately equally distributed between males (49.9%) and females (50.1%). More than half of the participants (for both males and females) belonged to upper and upper-middle Wealth Index categories. About 50% of males and females were involved in manual labour and wage-earning activities. More than one-third of males and females had monthly income below 5000 rupees. More than one-third of participants were secondary pass, and the percentages of non-literates were high among females (41%) and males (23.6%), but it was much higher among females compared to males. House types have shown 57.1% pucca floor, 40.8% pucca roof, and 48.1% pucca wall. Furthermore, more than two-fifth of participants were general caste, followed by scheduled castes (SC), other backward classes (OBC), and scheduled tribes (ST). These eight socioeconomic factors were selected after some trial and error and these variables do not show any multicollinearity, when used as regressors. All these factors were categorized and coded in ascending order for multinomial logistic regression.

i) Factors associated to double burden of malnutrition among the males:

Multinomial logistic regression (MLR) models have been used to predict socioeconomic factors affecting the double burden of malnutrition among males in Table 4a. BMI, the dependent variable, was categorized into three groups – undernourished (UW), normal, and overnourished (OW/O); normal group was selected as a reference category. The independent variables with variance inflation factors (VIF) < 3 were included in this model to avoid multicollinearity. The independent variables mainly consisted of Socioeconomic factors and age. Age was treated as a covariate because age had significant correlation with BMI. Pseudo-R-square statistics permits to assess of the predictive strength of the obtained MLR models. The regression model was significant. Since the reference category was normal, the regression showed the values of the coefficients of undernourished and overnourished along with their significance.

Age, wealth index (WI), earning activity (EA), monthly family income (MI) and house type – wall (WT) significantly predicted undernutrition (chronic energy deficiency (CED)). The coefficient of age was negative ($B = -0.01$, $p<0.01$), indicating that persons who were younger were more likely to be undernourished.

Table 4a: Multinomial logistic regression model that reflects the socioeconomic determinants that influence double burden of malnutrition among male

Independent Variables	Undernutrition [Odds: P (Yi = UW) / P (Yi = N)]						Overnutrition [Odds: P (Yi =OW&O) / P (Yi = N)]					
	B	SE	p	OR	95% CI (OR)		B	SE	p	OR	95% CI (OR)	
					Lower	Upper					Lower	Upper
Intercept	-1.46	0.73	0.05				-1.10	1.04	0.29			
Age	-0.01*	0.00	0.00	0.99	0.98	0.99	0.00	0.00	0.42	1.00	1.00	1.01
wi1[a]	1.08*	0.25	0.00	2.95	1.82	4.77	-0.68	0.61	0.27	0.51	0.15	1.68
wi2[a]	0.76*	0.22	0.00	2.15	1.38	3.33	-0.23	0.45	0.61	0.80	0.33	1.92
wi3[a]	0.73*	0.21	0.00	2.07	1.38	3.10	-0.30	0.39	0.45	0.74	0.34	1.60
wi4[a]	0.32*	0.14	0.02	1.38	1.05	1.81	-0.30	0.21	0.15	0.74	0.49	1.11
ea1[b]	-0.67*	0.34	0.05	0.51	0.26	1.00	-0.92	0.55	0.09	0.40	0.14	1.16
ea2[b]	-0.43	0.36	0.23	0.65	0.32	1.31	-0.57	0.56	0.31	0.57	0.19	1.71
ea3[b]	-0.82*	0.35	0.02	0.44	0.22	0.88	-0.17	0.53	0.75	0.84	0.30	2.38
ea4[b]	-0.95*	0.37	0.01	0.39	0.19	0.80	-0.62	0.54	0.25	0.54	0.19	1.56
ea5[b]	-0.89*	0.36	0.01	0.41	0.20	0.84	-0.43	0.57	0.44	0.65	0.21	1.97
ea6[b]	-0.97*	0.39	0.01	0.38	0.18	0.81	-0.13	0.55	0.81	0.88	0.30	2.55
mi1[c]	1.18*	0.44	0.01	3.24	1.37	7.67	-0.98*	0.35	0.01	0.38	0.19	0.74
mi2[c]	1.17*	0.44	0.01	3.23	1.38	7.59	-0.84*	0.32	0.01	0.43	0.23	0.81
mi3[c]	0.99*	0.43	0.02	2.68	1.14	6.27	-0.73*	0.30	0.02	0.48	0.27	0.87
mi4[c]	0.99*	0.43	0.02	2.70	1.16	6.31	-0.71*	0.29	0.02	0.49	0.28	0.87
mi5[c]	0.68	0.43	0.11	1.98	0.86	4.59	-0.34	0.26	0.18	0.71	0.43	1.17
e1[d]	0.75	0.42	0.07	2.11	0.93	4.77	-1.55*	0.40	0.00	0.21	0.10	0.47
e2[d]	0.57	0.42	0.17	1.77	0.78	4.00	-0.52	0.35	0.14	0.60	0.30	1.19
e3[d]	0.50	0.41	0.22	1.65	0.75	3.66	-0.75*	0.29	0.01	0.48	0.27	0.84
e4[d]	0.44	0.41	0.28	1.55	0.70	3.43	-0.70*	0.28	0.01	0.50	0.29	0.86
ft1[e]	-0.02	0.21	0.92	0.98	0.65	1.47	0.85	0.66	0.20	2.34	0.64	8.48
ft3[e]	-0.19	0.21	0.36	0.83	0.56	1.24	0.41	0.64	0.52	1.51	0.43	5.26
rt1[f]	-0.01	0.11	0.89	0.99	0.80	1.21	0.06	0.28	0.83	1.06	0.61	1.84
rt2[f]	-0.10	0.14	0.50	0.91	0.68	1.21	0.15	0.28	0.59	1.17	0.67	2.02
wt1[g]	-0.12	0.14	0.42	0.89	0.67	1.18	-0.21	0.35	0.55	0.81	0.41	1.62
wt3[g]	0.41*	0.17	0.01	1.51	1.09	2.09	0.22	0.37	0.54	1.25	0.61	2.57
c1[h]	0.08	0.19	0.69	1.08	0.74	1.57	0.63	0.49	0.20	1.87	0.71	4.92
c2[h]	-0.01	0.21	0.96	0.99	0.66	1.48	0.61	0.51	0.23	1.84	0.67	5.04
c3[h]	0.20	0.18	0.27	1.22	0.86	1.75	0.40	0.50	0.42	1.50	0.56	3.99

Model fitting information: Male - Chi-Square 576.078 ($p<0.01$); -2 Log Likelihood: 5977.758, wi, ea, etc. are as in Table 3. Reference category: a = wi5, b = ea7, c = mi6, d = e5,e = ft2, f = rt3, g = wt2,h = c4
*Significant; UW = Underweight, N = Normal, OW&O = Overweight and obese
B = Beta coefficient, SE = Standard Error, p = p-value, OR = Odds ratio, CI = Confidence interval

Beta coefficient and associated p-values of the selected categories indicate that:

a) As wealth index increases the risk of becoming undernourished becomes significantly less and less.
b) Occupation (ea) has negative influence compared to 'other' category and the influence is more or less same for all these categories except base category. This means that the risk of becoming undernourished is more or less same in all the categories except the 'other' category, which has more risk.
c) The effect of monthly income and education are like that of wealth index. Higher monthly income or level of education implies lower risk of undernutrition.

d) House types and Castes do not have significant effect on undernutrition.

Along with the coefficients and their significance, odds ratios (ORs) have also been calculated. ORs show the ratios between the probability of being undernourished given the category to probability of not being undernourished given the category.

For prediction of overnutrition among the males, the coefficients give just the opposite results except for the occupations. Significant predictors, that affecting on overnutrition among the male were monthly family income (MI), education (E).

ii) Factors associated to double burden of malnutrition among the females:

Table 4b: Multinomial logistic regression model that reflects the socioeconomic determinants that influence double burden of malnutrition among female

Independent Variables	Undernutrition [Odds: P (Yi = UW) / P (Yi = N)]						Overnutrition [Odds: P (Yi =OW&O) / P (Yi = N)]					
	B	SE	p	OR	95% CI (OR)		B	SE	p	OR	95% CI (OR)	
					Lower	Upper					Lower	Upper
Intercept	-1.65	0.77	0.03				-2.52	0.80	0.00			
Age	-0.01*	0.00	0.00	0.99	0.98	1.00	0.01*	0.00	0.02	1.01	1.00	1.02
wi1[a]	0.75*	0.26	0.00	2.11	1.28	3.50	-0.69	0.41	0.09	0.50	0.23	1.12
wi2[a]	0.68*	0.24	0.00	1.97	1.24	3.14	-0.19	0.32	0.56	0.83	0.44	1.56
wi3[a]	0.38	0.22	0.08	1.46	0.95	2.24	-0.03	0.27	0.93	0.98	0.57	1.67
wi4[a]	0.08	0.15	0.60	1.08	0.81	1.44	0.01	0.15	0.92	1.01	0.76	1.36
ea1[b]	-0.12	0.24	0.63	0.89	0.56	1.42	0.79	0.45	0.08	2.20	0.91	5.34
ea2[b]	0.02	0.27	0.94	1.02	0.61	1.72	0.92*	0.47	0.05	2.50	0.99	6.33
ea3[b]	-0.24	0.26	0.36	0.79	0.47	1.31	1.21*	0.46	0.01	3.34	1.37	8.16
ea4[b]	-0.32	0.29	0.26	0.72	0.41	1.27	1.25*	0.46	0.01	3.47	1.41	8.59
ea5[b]	-0.27	0.28	0.34	0.76	0.44	1.33	1.16*	0.47	0.01	3.19	1.26	8.08
ea6[b]	-0.40	0.30	0.18	0.67	0.37	1.20	1.01*	0.47	0.03	2.74	1.10	6.87
mi1[c]	1.10*	0.45	0.01	3.02	1.26	7.23	-0.55*	0.28	0.05	0.58	0.33	1.00
mi2[c]	1.09*	0.44	0.01	2.97	1.25	7.08	-0.49	0.27	0.07	0.61	0.36	1.04
mi3[c]	1.20*	0.44	0.01	3.32	1.40	7.87	-0.55*	0.26	0.04	0.58	0.34	0.97
mi4[c]	0.97*	0.44	0.03	2.63	1.11	6.23	-0.46	0.26	0.07	0.63	0.38	1.04
mi5[c]	0.55	0.44	0.21	1.73	0.73	4.07	-0.25	0.23	0.28	0.78	0.50	1.23
e1[d]	0.25	0.53	0.64	1.29	0.46	3.64	-0.34	0.42	0.42	0.71	0.32	1.62
e2[d]	-0.09	0.53	0.87	0.92	0.32	2.60	-0.31	0.41	0.45	0.73	0.32	1.65
e3[d]	0.06	0.52	0.91	1.06	0.38	2.94	-0.19	0.39	0.64	0.83	0.39	1.79
e4[d]	0.31	0.53	0.56	1.36	0.48	3.82	-0.10	0.39	0.81	0.91	0.42	1.97
ft1[e]	-0.02	0.21	0.92	0.98	0.65	1.48	-0.53	0.31	0.09	0.59	0.32	1.09
ft3[e]	0.04	0.21	0.84	1.04	0.69	1.58	-0.42	0.29	0.15	0.66	0.37	1.16
rt1[f]	-0.01	0.11	0.95	0.99	0.80	1.23	-0.02	0.20	0.93	0.98	0.66	1.46
rt2[f]	0.04	0.15	0.79	1.04	0.77	1.41	0.41*	0.19	0.03	1.51	1.03	2.20
wt1[g]	0.06	0.15	0.67	1.07	0.80	1.42	0.19	0.24	0.43	1.21	0.76	1.94
wt3[g]	0.07	0.17	0.68	1.08	0.77	1.51	0.15	0.24	0.53	1.16	0.73	1.84
c1[h]	-0.11	0.19	0.55	0.90	0.62	1.29	0.92*	0.37	0.01	2.52	1.22	5.20
c2[h]	-0.17	0.21	0.41	0.84	0.56	1.27	0.73	0.39	0.06	2.08	0.97	4.45
c3[h]	0.15	0.18	0.40	1.16	0.82	1.64	0.43	0.37	0.25	1.53	0.74	3.19

Model fitting information: Female - Chi-Square 564.135 ($p<0.01$); -2 Log Likelihood: 6545.745
Reference category: a = wi5, b = ea7, c = mi6, d = e5, e = ft2, f = rt3, g = wt2, h = c4
*Significant; UW = Underweight, N = Normal, OW&O = Overweight and obese
B = Beta coefficient, SE = Standard Error, p = p-value, OR = Odd ratio, CI = Confidence interval

Table 4b shows the results of multinomial logistic regression (MLR) model to predict the double burden of malnutrition among females by socioeconomic factors. Dependent and independent variables were taken in the same way as in males. The model fitted the data well. Here also normal group was selected as a reference category.

Age, wealth index (WI) and monthly family income (MI), could significantly predict undernutrition among the female. Age was a significant negative predictor (B = -0.01, $p<0.01$), indicating that younger women were more likely to have undernutrition than normal-BMI. The regression results for females were similar to those of males. Beta coefficients and the associated p-values in this case indicate that age, wealth index and monthly income have significant effect on the undernutrition when compared with their respective base categories, whereas most of the variable could predict overnutrition significantly. Among the females, significant predictors that affected overnutrition were Age, earning activity (EA), monthly family income (MI), house type – roof (RT), caste (C) (Table 4b).

DISCUSSION:

Age was found to be a significant factor for both males and females towards prediction of undernutrition and overnutrition (Table 1b). At the same time, these indicators differ between the males and females, which was noticeable in each age group (Table 1a). The tendency to decrease height has been found with increasing age (Table 2b). Weight gain was associated only with male, though both waist and hip circumference increased with age. Undernutrition or chronic energy deficiency (CED) was more common among males of all ages than among females (Table 2a), whereas overnutrition was comparatively more among females than males in each age group. The distribution of regional fat (WHR) shows that obesity was more than 40% below 40 years and more than 70% over 40 years, but no remarkable difference was found between males and females. Central obesity (WHtR) was more frequent in female rather than male, and it increased with age. Prevalence of obesity was considerably greater in terms of central obesity (WHtR) and regional fat distribution (WHR), while the proportion of overweight was much higher than obesity as per BMI, yet both overweight and obesity imply overnutrition. This particular distribution of nutritional indicators of obesity indicates that the nutritional status shifted from overweight to obesity. As a result, a clear account of the double burden of malnutrition has been obtained among the Bengali adults.

The present study was undertaken in rural and peri-urban areas, so an impact of this place was found on the socioeconomic status of the people here. More than half of the people belonged to the working class, but very few were in agriculture or farming. There were salaried employees, but not many. More than half of the people have a monthly income below 7500 rupees. Though most of them are non-literate, the prevalence of higher education was also found among men than women. Mud-built and brick-built houses were found with almost equal frequencies. More than 80% of the people belonged to the general or scheduled castes categories, and the number of STs was much lower (Table 3). The socioeconomic factors have profound influence on people's nutritional status.

Multinational logistic regression models have shown some interesting results. Regarding the influence of age on undernutrition, this study revealed an inverse relationship between age and the odds of undernutrition among both males and females. The prevalence of undernutrition was more frequent among the younger generation. Wealth index and monthly family income, socioeconomic factors, were found to be significant predictors for undernutrition among males and females. Earning activity and house type (wall) were two additional factors associated with men. The majority of people who were undernourished came from the family with low wealth index and monthly family income, both of which suggest a poor economic condition. Men who worked in the public or private service sector were less undernourished. In case of overnutrition, only monthly family income has been found to be a significant factor common to both men and women. Families with relatively high income tend to be overnourished. Furthermore, education had significant role towards overnutrition; non-literate men were less likely to be overnourished. Other factors, such as women who were involved in the public or private sector and those who lived in a house with a pucca-roof, contribute to overnutrition. All these indicators, thus, point to rich economic conditions. Overnutrition was more prevalent among elderly women and those who belonged to the general caste. To summarize, monthly family income was the most consistent predictor of double burden of malnutrition, and this is true for both men and women.

Researches in different developing and underdeveloped countries have found evidence that socio-economic conditions affect nutritional status. A study was conducted in 2015-16 among adult women (18-49 years) in Myanmar, found a high prevalence of both underweight and overweight. Socio-demographic factors such as wealth status, education and place of residence have a significant effect on malnutrition. Upper educational group

(secondary), upper and lower (both) wealth status, and urban residence were found to be significant predictors of overweight (Hong et al., 2018).

In another study from Kenya based on the Demographic and Health Survey 2014, 20.5% and 9.1% of women were overweight and had obesity, respectively. One of the important associated factors to being overweight or obese was age, middle and old age group. Among the male, lower education, lower wealth status, inadequate fruit and vegetable consumption, adding daily sugar into beverages and having no hypertension were associated with being underweight. Among the female, higher education, greater wealth, being a Kikuyu by ethnic group, urban residence, no current tobacco use, low physical activity, and having hypertension were associated with underweight and obesity (Pengpid & Peltzer, 2020).

Trends in the prevalence of overweight/obesity were found among urban Women in Ethiopia based on a series of the Ethiopia Demographic and Health Survey (EDHS) data for the years 2000, 2005, 2011, and 2016. In urban Ethiopian women, the prevalence of underweight decreased from 23.2% in 2000 to 14.8% in 2016, whereas overweight/obesity increased from 10.9% in 2000 to 21.4% in 2016. Women from wealthy families and those who had never married were less likely to be underweight. Women from rich families and those with at least a secondary education were more likely to be overweight/obese (Ahmed et al., 2020). In Bangladesh, double the burden of malnutrition was found among adult women (15-49 years) underweight, overweight and obesity, 19.7%, 18.1% and 4.0%, respectively, based on Demographic and Health Surveys 2014 (Rahman et al., 2019). The present study and supportive studies indicate that the double burden of malnutrition is an important issue in developing countries and it has a relationship with socio-economic conditions.

CONCLUSION:

This article presented the coexistence of double burden of malnutrition and tried to find out the associated socioeconomic factors among Bengali adults in Birbhum, West Bengal. The results showed undernutrition or chronic energy deficiency (CED) was relatively high rather than overnutrition in the population. Central obesity and regional fat distribution indicated a transition from overweight to obesity. Overnutrition was found to be more prevalent among females than males, and various socioeconomic factors were found to be responsible for this. Age, wealth index and monthly family income were the common factors of undernutrition, counter wise only monthly family income was the common factor of overnutrition for both males and females. Undernutrition was more frequent at younger age, and the people who

had lower wealth index were mainly from lower family income groups. Overnutrition was found among the people with higher family incomes. In conclusion, the nutritional dissimilarities and economic inequality exist among the studied Bengali people, and this economic inequality was the major factor affecting the double burden of malnutrition.

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Conflict of interest:

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