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Double Burden of Malnutrition and Its Determinants among Women of Two Ethnicities in North Bengal, India

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Abstract

The double burden of malnutrition, defined as the coexistence of overweight/obesity with undernutrition in the population, has become an emerging public health problem in low-income and middle-income countries where its rising prevalence is now a significant health challenge. Obesity is a well-known risk factor for chronic illnesses including type II diabetes, hypertension, and cardiovascular disease. Also underweight has a direct effect on morbidity and mortality. The present cross-sectional study was done among 828 adult women (Rajbanshi: 414 and Namasudra: 414) aged 19-39 years of Maynaguri block, Jalpaiguri district, West Bengal, India. Asian-specific BMI cut-offs were used to assess the prevalence of underweight, overweight, and obesity. The present study documented a low prevalence of undernutrition among the studied population. According to Asia-specific cut-off values, the overall prevalence of underweight was 9.7%, and overall over-nutrition was 40.0% (overweight 18.0%, obesity 22.0%). The χ^2 analysis showed that most of the socioeconomic variables were statistically related with the nutritional condition of the population except for ethnicity and woman's educational level. Rajbanshi women had a higher prevalence of undernutrition than rates previously reported for Bengalee Kayastha and Nyishi women. Undernutrition among Namasudra women was lower than reported in earlier studies. However, the combined overweight-obesity prevalence was higher than previously reported among both ethnicities. The present study proves the existence of a double burden of malnutrition among the study populations, which is influenced by socioeconomic and demographic determinants. The results suggest a need to develop policies and programs tailored to specific socioeconomic and demographic groups to address the double burden of malnutrition. Intervention programs such as awareness campaigns and nutrition educational programs should be targeted according to the socioeconomic and demographic conditions.

Keywords: Double burden of malnutrition, Asia-specific cutoff, BMI, Rajbanshi, Namasudra

1 Introduction

The double burden of malnutrition (DBM), defined as the coexistence of undernutrition and overnutrition in the same population, has become an emerging public health problem in many parts of the world. DBM will be key to achieving the Sustainable Development Goals, in particular Goal 2 and Target 3.4, and the commitments of the Rome Declaration on Nutrition, within the UN Decade of Action on Nutrition (Oenema, 2019). The factors influencing DBM are complex, including both biological and environmental factors. Some of these factors may include poor water and sanitation systems, favouring diarrheal and parasitic diseases, and weak public health systems (Shrimpton & Rokx, 2012). Undernutrition among women is alarming in developing countries, especially in the South Asian region (Bhandari et al., 2016). Women of reproductive age are among the most susceptible to malnutrition for both social and biological reasons (Kamal & Islam, 2010). While globally, obesity has doubled in the last three decades, it has tripled in low- and medium-income countries (LMICs) in just two decades (WHO, 2011).
Obesity is a natural consequence of overnutrition and a sedentary lifestyle and tends to be strongly associated with gender and socioeconomic status, although the direction of these associations varies according to the

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levels of socioeconomic development (Monteiro et al., 2004; Roskam, 2010). Contrary to high-income countries, overweight/obesity has traditionally been most prevalent among high-income families and well-educated individuals in low- and middle-income countries (Dinsa et al., 2012; Neuman et al., 2013). The rising prevalence of overweight/obesity coexisting with persistent undernutrition is a significant health challenge in low-income and middle-income countries including India, where improved economic conditions, urbanization, sedentary lifestyles and dietary changes have caused a steady increase in overweight/obesity (Afshin et al., 2017 Agrawal et al., 2013; Dutta et al., 2019). Similarly, being underweight is strongly associated with premature mortality, disabilities, and poor health, especially in developing countries (Pednekar et al., 2008; Selvamani & Singh, 2018).

Being underweight, particularly, among women, has a direct effect on health being for example associated with anaemia, and indirectly contributing to maternal and infant mortality (Doku & Neupane, 2015). Also, overweight/obesity is a significant predictor of overall mortality (Whitlock et al., 2009) and of chronic diseases such as diabetes (Hossain et al., 2007), cardiovascular disease (Prabhakaran et al., 2018), and multimorbidity (Arokiasamy et al., 2015).

Factors related to adult underweight may include sociodemographic variables such as early adulthood (15-24 years) (Biswas et al., 2017), having lower education and poorer economic background (Biswas et al., 2017; Hanandita & Tampubolon, 2015; Lemato & Navaneetham, 2014; Siddiqui & Donato, 2017). Also, marital status, age, wealth index, educational level, type of fuel for cooking, and bath place are statistically associated with overnutrition and/or undernutrition.

The present study aims to assess the ethnicity-specific prevalence of double burden of malnutrition (undernutrition and overnutrition) and to examine the relationship of socioeconomic and demographic factors with nutritional conditions among women of both ethnic groups. It also aims to compare the prevalence of double burden of malnutrition of the studied women with other studies.

2 Material & Methods

The present cross-sectional study was done among 828 women (414 Rajbanshi and 414 Namasudra) aged 19-39 years of Maynaguri block, Jalpaiguri district, West Bengal, India. The Maynaguri block is situated at 26.57° north latitude and 88.82° east longitude (Fig. 1). According to Census (2011), the total population of Maynaguri block was 329,932, of which 291,073 were rural and 37,959 were urban residents. There were 170,030 (52%) males and 159,002 (48%) females. Women were randomly selected from 48 Integrated Child Development Scheme (ICDS) centres where their children were enrolled. Data were collected from ICDS centres located in different villages: Uttar Marich Bari, Dharmapur, Dakshin Ulladabri, Putimary, Razar Hat, Uttar Ulladabri, and Barnes. Ethnicity was identified from the polio card provided by the mothers of ICDS beneficiaries.

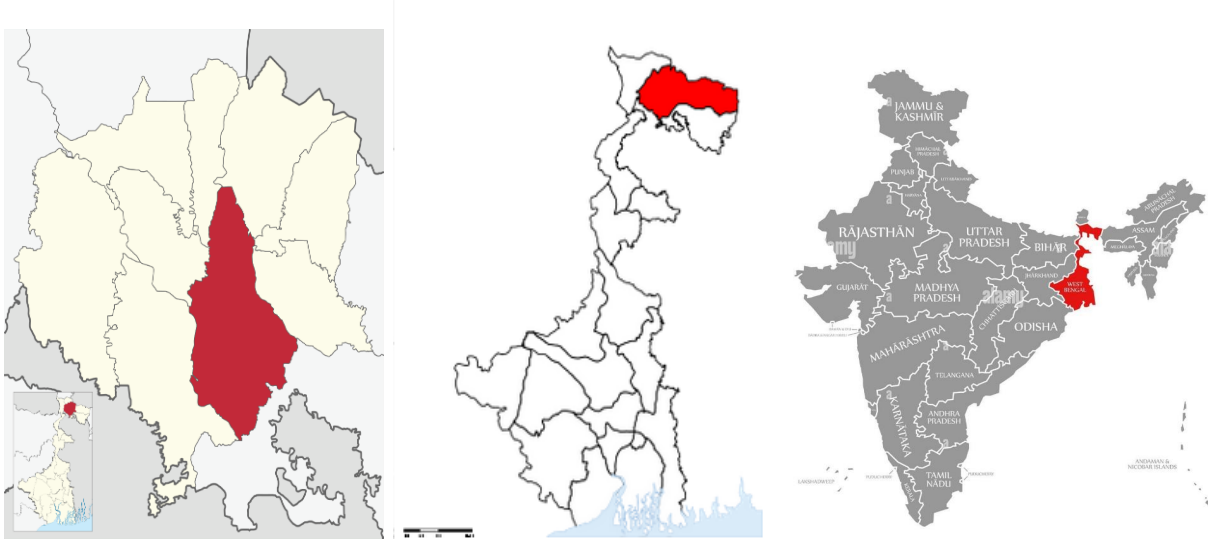

Figure 1. The study area

2.1 Ethnic groups

The Rajbanshi people belong to the Mongolo-Dravidian group. They are a traditionally agriculturist community that claims descent from the Koch. They are believed to have originally spoken a Tibeto-Burman language although they now speak an Indo-Aryan language and practice a form of Vedic Hinduism. They are an endogamous group classified as a Scheduled Caste, although they claim Kshatriya status based on their alleged descent from the 16^{th}-century Koch dynasty.
The Namasudra are believed to be of non-Aryan origin although today they mostly speak the Bengali language. They are mainly agriculturists and boatmen. Risley (1892) opined that the Namasudra are related to the tribe of the Vedic period called Chandal, initially used to refer to the broad group of people sharing a similar despised social position. The Chandal/Namasudra have traditionally been a low-caste (Dalit) group in West Bengal. Namasudra are today categorised as a Scheduled Caste population in the Hindu caste system.

2.2 Data collection

Anthropometric data such as height and weight was collected by the standard procedure developed by Weiner and Lourie (1981), and sociodemographic data (ethnicity, birth weight of child, age groups, education level, type of fuel used for cooking, bath place, source of drinking water, husband's occupation, income) were collected on a structured schedule by first author A.B. Ethical permission was obtained from the University of North Bengal.

2.3 Asia-specific BMI cutoff

The body mass index was calculated as weight (kg) / height (m^2). Asian-specific BMI cut-offs were used to define underweight, overweight and obesity (Tan 2004).

2.4 Statistical Analysis

All types of statistical analysis such as mean, standard deviation, F test, χ^2 test and multinominal regression were done on the Statistical Package for Social Science (SPSS 18). F test was done to analyse age-specific variation. χ^2 tests were used to identify differences in proportions of the categories of exposure by nutritional status of women. Multinominal analysis was done to assess which ones of the predictor variables influence the likelihood of different outcomes most directly, as risk factors of the observed nutritional conditions. For the present study, socioeconomic demographic factors were the predictor variables and nutritional status was the outcome.

3 Results

Table 1 shows that the mean height, weight and BMI of Rajbanshi women were 150.9 cm, 51.4 kg and 22.5 kg/m^2 respectively. The mean height, weight and BMI of Namasudra women were 149.8 cm, 51.4 kg and 22.9 kg/m^2 respectively. Namasudra women but not Rajbanshi women showed, statistically significant age variations for all variables. Ethnic differences in anthropometric variables were not statistically significant.

Table 1: Descriptive statistics of height, weight and BMI of studied populations. Means, with standard deviations in parentheses.

Rajbanshi women				
Age (years)	N	Height (cm)	Weight (kg)	BMI (kg/m^2)
<25	122	150.16 (5.85)	50.07 (9.56)	22.31 (3.53)
25–30	167	151.22 (5.27)	51.34 (8.29)	22.43 (3.32)
>30	125	151.14 (5.49)	52.59 (10.56)	22.97 (4.16)
Total	414	150.89 (5.52)	51.35 (9.43)	22.50 (3.66)
F test		1.49NS	0.11NS	0.18NS
Namasudra women				
Age (years)	N	Height (cm)	Weight (kg)	BMI (kg/m^2)
<25	114	149.31 (5.58)	48.94 (8.60)	21.90 (3.36)
25–30	199	148.89 (5.25)	50.44 (8.68)	22.69 (3.32)
>30	101	152.08 (5.67)	56.16 (10.31)	24.26 (4.14)
Total	414	149.78 (5.59)	51.42 (9.47)	22.85 (3.64)
F test		12.10***	19.16***	12.20***

*** Significant at $p < .001$

Table 2 shows, based on Asia-specific cut-off values, that the overall prevalence of underweight was 9.7%. Overweight was 18% and obesity 22%, adding up to a combined overnutrition of 40%. There was 10.9% undernutrition and 38.2% combined overnutrition found in Rajbanshi women. Whereas, 8.5% undernutrition and 41.8% overnutrition were found among Namasudra women.

Table 2. Prevalence of double burden of malnutrition among the studied population, numbers, with percent in parentheses

Table 2:

Population	Underweight (%)	Overweight (%)	Obese (%)	Combined overnutrition (%)
Rajbanshi	45 (10.90)	73 (17.63)	85 (20.53)	158 (38.16)
Namasudra	35 (8.45)	76 (18.36)	97 (23.42)	173 (41.78)
Total	80 (9.66)	149 (18.00)	182 (21.98)	331 (39.98)

Table 3 depicts the frequency and percentage distribution of Asia-specific cut-off categories in different socioeconomic demographic groups. The χ^2 analysis shows statistically significant associations with nutritional categories for most of the socioeconomic variables such as birth weight of child, age groups, type of fuel used for cooking, bath place, source of drinking water, husband's occupation and income, but not ethnicity and educational level of women.

Table 3. Frequency of nutritional categories using Asia-specific cut-offs[1] with % in parentheses, and χ^2 analysis. * $p < .05$, *** $p < .001$, NS, not significant

Table 3:

Variables	Underweight	Normal	Overweight	Obese	Total	χ^2
Ethnicity						
Rajbanshi	45 (5.43)	211 (25.48)	73 (8.82)	85 (10.26)	414 (50.00)	2.16NS
Namasudra	35 (4.23)	206 (24.88)	76 (9.18)	97 (11.71)	414 (50.00)	
Birth weight of child						
<2.500kg	24 (2.90)	142 (14.15)	40 (4.83)	27 (3.26)	233 (28.14)	**23.40*** **
>2.500kg	56 (6.76)	275 (33.21)	109 (13.16)	155 (18.72)	595 (71.86)	
Age groups (Years)						
<25	31 (3.74)	128 (15.46)	30 (3.62)	47 (5.68)	236 (28.50)	**25.01*** **
25-30	32 (3.86)	198 (23.91)	61 (7.37)	75 (9.06)	366 (44.20)	
>30	17 (2.03)	91 (10.99)	58 (7.00)	60 (7.25)	226 (27.29)	
Education level						
Primary	27 (3.26)	175 (21.13)	60 (7.25)	56 (6.76)	318 (38.40)	16.20NS
Secondary	30 (3.62)	154 (18.60)	54 (6.52)	70 (8.45)	308 (37.20)	
Higher sec.	20 (2.41)	71 (8.57)	28 (3.38)	38 (4.59)	157 (18.86)	
Graduation+	3 (0.36)	17 (2.05)	7 (0.84)	18 (2.17)	45 (5.44)	
Type of fuel used for cooking						
Wood	58 (7.00)	330 (39.85)	94 (11.35)	112 (13.53)	594 (71.74)	**28.88*** **
Crop residue	1 (0.12)	9 (1.09)	2 (0.24)	4 (0.48)	16 (1.93)	
LPG	21 (2.54)	78 (9.42)	53 (6.40)	66 (7.97)	218 (26.33)	
Bath place						
Open	26 (3.14)	157 (18.96)	55 (6.64)	40 (4.83)	278 (33.57)	**14.87***
Closed	54 (6.52)	260 (31.40)	94 (11.35)	142 (17.15)	550 (66.42)	
Source of drinking water						
Tube well	51 (6.16)	317 (38.28)	106 (12.80)	130 (15.70)	604 (72.95)	**31.39*** **
Tap water	1 (0.12)	18 (2.17)	10 (1.21)	4 (0.48)	33 (3.99)	
Well water	20 (2.41)	65 (7.85)	27 (3.26)	24 (2.90)	136 (16.42)	
Mineral water	8 (0.97)	17 (2.05)	24 (2.90)	6 (0.72)	55 (6.64)	
Husband's occupation						
Labour	20 (2.41)	142 (17.15)	37 (4.47)	37 (4.47)	236 (28.50)	**37.277*** **

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Table 3: (Continued)

Variables	Underweight	Normal	Overweight	Obese	Total	χ^2
Cultivation	30 (3.62)	135 (16.30)	44 (5.31)	53 (6.40)	262 (31.65)	
Business	12 (1.45)	57 (6.88)	35 (4.23)	50 (6.04)	154 (18.60)	
Employee	4 (0.48)	46 (5.55)	20 (2.41)	26 (3.14)	96 (11.59)	
Others	14 (1.69)	37 (4.47)	13 (1.57)	16 (1.93)	80 (9.66)	
Income (INR)						
<7500	28 (3.38)	147 (17.75)	38 (4.59)	38 (4.59)	251 (30.31)	**33.621*** **
7500-15000	44 (5.31)	228 (27.54)	79 (9.54)	99 (11.96)	450 (54.35)	
>15000	8 (0.97)	42 (5.07)	32 (3.86)	45 (5.43)	127 (15.34)	

[1] Cut-offs are: BMI $<$ 18.5 = underweight; BMI 18.5–22.9 = normal; BMI 23–24.9 = overweight; BMI 25+ = obese

Table 4 describes the ethnicity-specific prevalence of the double burden of malnutrition. χ^2 analysis shows how socioeconomic and demographic factors such as birth weight of children, type of fuel for cooking and income influence the nutritional status of women of both ethnicities. Statistically significant relationships of age group, educational level, source of drinking water, and husband's occupation are seen only in the Namasudra women but not the Rajbanshi. However, bath place had a statistically significant relation with double burden of malnutrition only among the Rajbanshi.

Table 4. Ethnicty-specific χ^2 analysis of the prevalence of DBM with socioeconomic variables among the studied populations. Numbers with % in parentheses. * p <.05, *** p < .001, NS, not significant

Table 4:

Variables	Under-weight	Nor-mal	Over-weight	Obese	χ^2	Under-weight	Nor-mal	Over-weight	Obese	χ^2
Birth weight of child										
<2.500kg	11 (2.7)	53 (12.8)	15 (3.6)	5 (1.2)	**14.44***	13 (3.1)	89 (21.5)	25 (6.0)	22 (5.3)	**12.45***
>2.500kg	34 (8.2)	158 (44.7)	58 (14.0)	80 (19.3)		22 (5.3)	117 (28.3)	51 (12.3)	75 (18.1)	
Age group (years)										
<25	18 (4.4)	63 (15.2)	16 (3.9)	25 (6.0)	9.63N	13 (3.1)	65 (15.7)	14 (3.4)	22 (5.3)	**22.59*** **
25-30	13 (3.1)	94 (22.7)	28 (6.8)	32 (7.7)		19 (4.6)	104 (25.1)	33 (8.0)	43 (10.4)	
>30	14 (3.4)	54 (13.0)	29 (7.0)	28 (6.8)		3 (0.7)	37 (8.9)	29 (7.0)	32 (7.7)	
Education level										

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Table 4: (Continued)

Variables	Under-weight	Nor-mal	Over-weight	Obese	χ^2	Under-weight	Nor-mal	Over-weight	Obese	χ^2
Primary	15 (3.6)	78 (18.8)	22 (5.3)	28 (6.8)	5.28NS	12 (2.9)	97 (23.4)	38 (9.2)	28 (6.8)	**17.88***
Secondary	14 (3.4)	82 (19.8)	31 (7.5)	31 (7.5)		16 (3.9)	72 (17.4)	23 (5.6)	39 (9.4)	
Higher sec.	14 (3.4)	43 (10.4)	17 (4.1)	20 (4.8)		6 (1.5)	28 (6.8)	11 (2.7)	18 (4.4)	
Graduation+	2 (0.5)	8 (1.9)	3 (0.7)	6 (1.5)		1 (0.2)	9 (2.2)	4 (1.0)	12 (2.9)	
Type of fuel used for cooking										
Wood	30 (7.3)	177 (42.8)	53 (12.8)	57 (13.8)	**15.40***	28 (6.8)	153 (37.0)	41 (9.9)	55 (13.3)	**21.10***
Crop residue	1 (0.2)	2 (0.5)	0 (0.0)	2 (0.5)		1 (0.2)	7 (1.7)	2 (0.5)	2 (0.5)	
LPG	14 (3.4)	32 (7.7)	26 (6.3)	20 (4.8)		7 (1.7)	46 (11.1)	33 (8.0)	40 (9.7)	
Bath place										
Open	17 (4.1)	83 (20.1)	35 (8.5)	19 (4.6)	**12.05***	9 (2.2)	74 (17.9)	20 (4.8)	21 (5.1)	7.47NS
Closed	28 (6.8)	128 (30.9)	38 (9.2)	66 (15.9)		26 (6.3)	132 (31.9)	56 (13.5)	76 (18.4)	
Source of drinking water										
Tube well	30 (7.3)	166 (40.1)	55 (13.3)	65 (15.7)	10.97N	21 (5.1)	151 (36.5)	51 (12.3)	65 (15.7)	**24.30***
Tap water	1 (0.2)	5 (1.2)	4 (1.0)	2 (0.5)		0 (0.0)	13 (3.1)	6 (1.5)	2 (0.5)	
Well water	10 (2.4)	35 (8.5)	11 (2.7)	11 (2.7)		10 (2.4)	30 (7.3)	16 (3.9)	13 (3.1)	
Mineral water	4 (1.0)	5 (1.2)	3 (0.7)	7 (1.7)		4 (1.0)	12 (2.9)	3 (0.7)	17 (4.1)	
Husband's occupation										
Labour	11 (2.7)	72 (17.4)	22 (5.3)	26 (6.3)	20.43NS	9 (2.2)	70 (16.9)	15 (3.6)	11 (2.7)	**33.46*****
Cultivation	14 (3.4)	76 (18.4)	25 (6.0)	25 (6.0)		16 (3.9)	59 (14.3)	19 (4.6)	28 (6.8)	

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Table 4: (Continued)

Variables	Under-weight	Nor-mal	Over-weight	Obese	χ^2	Under-weight	Nor-mal	Over-weight	Obese	χ^2
Business	7 (1.7)	19 (4.6)	10 (2.4)	16 (3.9)		5 (1.2)	38 (9.2)	25 (6.0)	34 (8.2)	
Employee	1 (0.2)	25 (6.0)	7 (1.7)	10 (2.4)		3 (0.7)	22 (5.3)	13 (3.1)	16 (3.9)	
Others	12 (2.9)	20 (4.8)	9 (2.2)	8 (1.9)						
Income (INR)										
<7500	20 (4.8)	80 (19.3)	24 (5.8)	22 (5.3)	**17.18***	8 (1.9)	67 (16.2)	14 (3.4)	16 (3.9)	**22.11****
7500-15000	23 (5.6)	116 (28.0)	41 (9.9)	45 (10.9)		21 (5.1)	112 (27.1)	38 (9.2)	54 (13.0)	
>15000	2 (0.5)	15 (3.6)	8 (1.9)	18 (4.4)		6 (1.5)	27 (6.5)	24 (5.8)	27 (6.5)	

Table 5 depicts that women who used tube well water as a source of drinking water and husband in the labour category were less likely than the reference category to be underweight. Overweight associated with higher income, liquefied propane gas (LPG) as fuel for cooking, and older age. Obesity associated with higher income, closed bath place, mineral water as source of drinking water, LPG as fuel for cooking, older age, and a lesser likelihood of having a low birth weight child.

Table 5: Multinomial regression with malnutrition categories as dependent variables and socio-economic/demographic predictors.

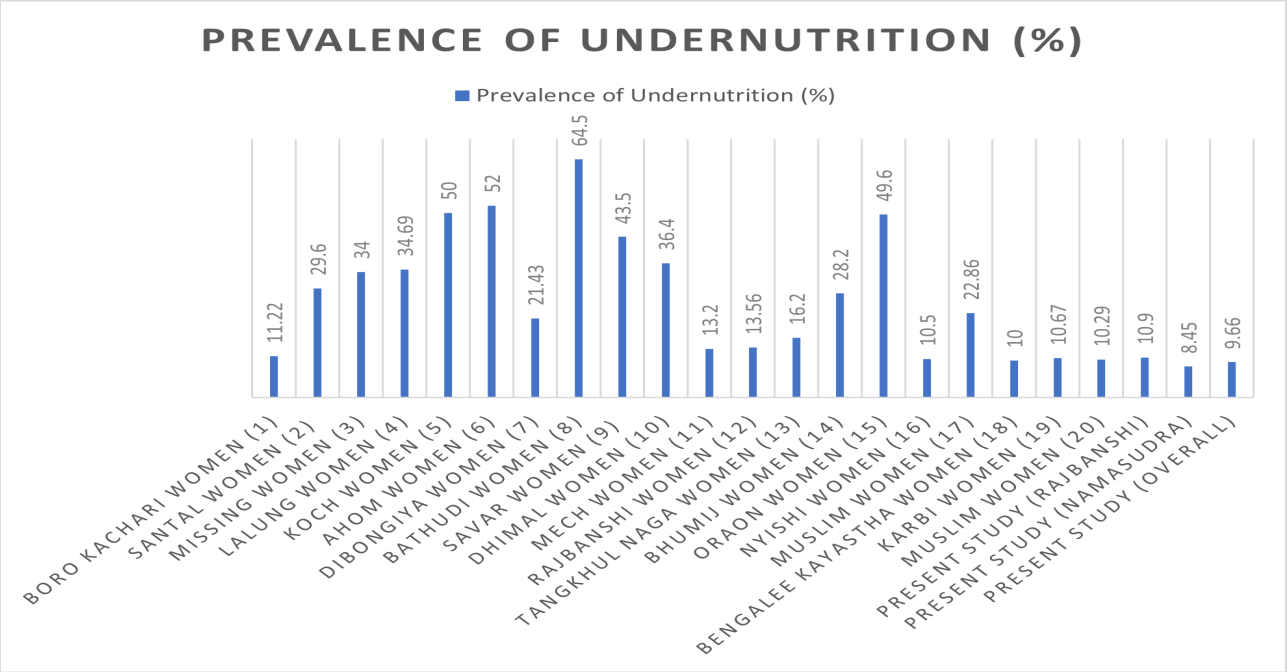
Variables	Category 1					Category 2					Category 3				
	B	**SE**	**Wald**	**OR**	**95% CI**	**B**	**SE**	**Wald**	**OR**	**95% CI**	**B**	**SE**	**Wald**	**OR**	**95% CI**
Ethnicity															
Rajbanshi	.159	.267	.352	1.172	(.69–1.98)	-.022	.211	.011	.978	(.64–1.48)	-.129	.198	.424	.879	(.60–1.29)
Namasudra[ref]															
Birth weight of child															
< 2.500 kg	-.105	.281	.140	.900	(.52–1.56)	-.205	.227	.814	.815	(.52–1.27)	-1.028	.247	17.354	**.358*** **	(.22–.58)
≥ 2.500 kg[ref]															
Age groups (years)															
<25	.355	.359	.982	1.427	(.71–2.89)	-1.182	.286	17.101	**.307*** **	(.17–.54)	-.425	.266	2.544	.654	(.39–1.10)
25–30	-.095	.344	.076	.910	(.46–1.78)	-.796	.238	11.181	**.451*** **	(.28–.71)	-.499	.234	4.539	**.607***	(.38–.96)
$\geq$30[ref]															
Education level															
Primary	-.375	.704	.283	.687	(.17–2.73)	.539	.530	1.037	1.715	(.60–4.84)	-.503	.426	1.390	.605	(.26–1.39)
Secondary	-.071	.696	.011	.931	(.24–3.64)	.508	.526	.933	1.663	(.59–4.66)	-.229	.420	.297	.795	(.34–1.81)
Higher sec.	.158	.713	.049	1.171	(.29–4.74)	.662	.550	1.449	1.938	(.66–5.69)	-.283	.442	.411	.753	(.31–1.79)
Graduation+[ref]															
Type of fuel used for cooking															
Wood	-.169	.327	.267	.844	(.44–1.60)	-.844	.252	11.237	**.430*** **	(.26–.70)	-.462	.237	3.803	**.630***	(.40–1.00)
Crop residue	-.653	1.106	.348	.521	(.06–4.55)	-1.406	.827	2.890	.245	(.05–1.24)	-.540	.666	.657	.583	(.16–2.15)
LPG[ref]															
Bath place															
Open	-.067	.282	.057	.935	(.54–1.62)	.209	.220	.905	1.232	(.80–1.89)	-.438	.225	3.801	**.645***	(.41–1.00)
Closed[ref]															

Table 5 (continued)

Variables	Category 1					Category 2					Category 3				
	B	SE	Wald	OR	95% CI	B	SE	Wald	OR	95% CI	B	SE	Wald	OR	95% CI
Source of drinking water															
Tube well	-1.072	.504	4.523	**.342***	(.13–.92)	.678	.526	1.660	1.970	(.70–5.53)	-.569	.377	2.287	.566	(.27–1.18)
Tap water	-2.134	1.133	3.546	.118	(.01–1.09)	.904	.649	1.943	2.470	(.69–8.80)	-1.682	.679	6.131	**.186***	(.05–.70)
Well water	-.425	.542	.617	.653	(.23–1.89)	.709	.561	1.596	2.033	(.68–6.11)	-.878	.434	4.090	**.416***	(.18–.97)
Mineral water[ref]															
Husband's occupation															
Labour	-.871	.412	4.458	**.419***	(.19–.93)	-.031	.382	.066	.970	(.45–2.08)	-.158	.368	.183	.854	(.41–1.75)
Cultivation	-.522	.390	1.791	.594	(.28–1.27)	-.136	.382	.127	.873	(.41–1.84)	-.091	.357	.065	.913	(.45–1.84)
Business	-.798	.487	2.692	.450	(.17–1.17)	.233	.420	.309	1.263	(.55–2.87)	.362	.387	.877	1.436	(.67–3.06)
Employee	-1.658	.648	6.538	.191	(.05–.68)	.036	.456	.006	1.037	(.42–2.54)	-.163	.430	.144	.850	(.37–1.97)
Others[ref]															
Income															
INR < 7500	-.009	.507	.012	.991	(.37–2.67)	-.727	.368	3.899	**.483***	(.23–.99)	-.716	.344	4.338	**.489***	(.24–.96)
INR 7500–15000	-.152	.458	.110	.859	(.35–2.11)	-.620	.307	4.078	**.538***	(.29–.98)	-.579	.282	4.203	**.560***	(.32–.97)
INR > 15000[ref]															

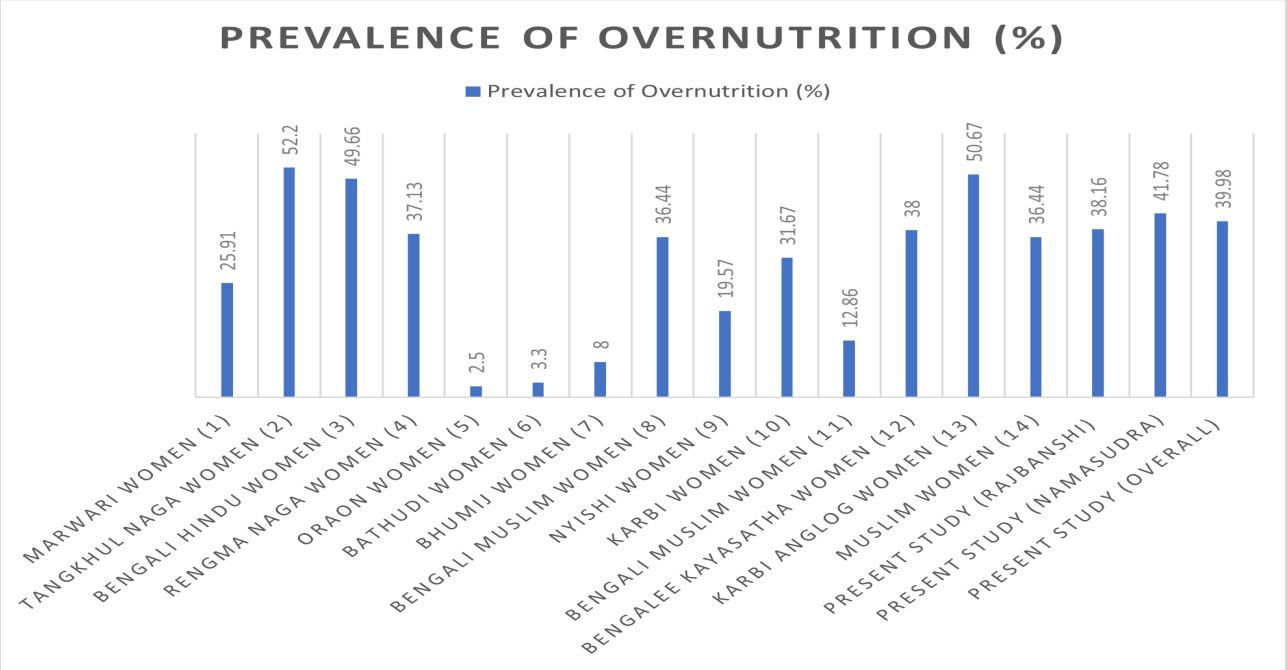
* $p < .05$, *** $p < .001$, [ref] reference category.

Figure 2. Comparison of undernutrition between the present study and previous studies (1) - Khongsdier



2001; (2) - Khongsdier 2001; (3) - Khongsdier 2001; (4) - Khongsdier 2001; (5) - Khongsdier 2001; (6) - Khongsdier 2001; (7) - Gogoi & Sengupta 2002; (8) - Bose & Chakraborty 2005; (9) - Bose et al., 2006 (10) - Datta Banik et al., 2007; (11) - Datta Banik et al., 2009; (12) - Datta Banik et al., 2009; (13) - Mungreipy & Kapoor 2010; (14) - Kshatriya & Acharya 2016; (15) - Kshatriya & Acharya 2016; (16) - Bharali et al., 2017; (17) - Tigga et al., 2018; (18) - Debnath et al., 2019; (19) - Sharma & Mondal 2020; (20) - Debnath 2020.

Figure 3. Comparison of combined overweight-obesity with previous studies. Sources: (1) - Das & Bose



2006; (2) - Mungreipy & Kapoor 2010; (3) - Sen et al., 2013; (4) - Rengma et al., 2015; (5) - Kshatriya &

Acharya 2016; (6) - Kshatriya & Acharya 2016: (7) - Kshatriya & Acharya 2016; (8) - Kalaiselvi et al., 2016; (9) - Bharali et al., 2017; (10) - Mondal et al., 2017; (11) - Tigga et al., 2018; (12) - Debnath et al., 2019; (13) - Sharma & Mondal 2020; (14) - Debnath 2020.

4 Discussion

The co-existence of underweight and overweight/obesity within the same population is called the double burden of malnutrition (Kapoor & Anand, 2002; Khan & Khoi, 2008). The present findings suggest that the dual burden of malnutrition persists in India. Underweight is still prevalent while the prevalence of overweight/obesity is increasing rapidly, particularly among women. According to Asia-specific cut-off values, the present study has documented a low prevalence of undernutrition and a high prevalence of overnutrition among the studied population. Asia-specific cut-offs show the prevalence of overall undernutrition as 9.7% whereas overall over-nutrition was 40.0% (overweight 18.0%, obesity 22.0%).

Asia-specific cut-offs show Rajbanshi women have 10.9% undernutrition and Namasudra women have 8.5% undernutrition. Asia-specific cut-offs place 38.2% of Rajbanshi women in the overnutrition category (overweight 17.6%, obesity 20.5%), and 41.8% of Namasudra women (overweight 18.4%, obesity 23.4%). This shows that the prevalence of double burden of malnutrition is similar for these two ethnicities in Jalpaiguri, West Bengal, India. Recent literature shows that individuals living in developing countries tend to be particularly vulnerable to obesity-related diseases and comorbidities (Bhurosy & Jeewon, 2014; Sen et al., 2013; Tremmel et al., 2017). India has one of the world's highest rates of undernutrition despite evidence of rising overweight-obesity in the urban population. Recent observations showed a rising risk of overweight and obesity also in rural settings, especially among women and among individuals of high socioeconomic status (Dutta et al., 2019; Kulkarni et al., 2017; Mungreiphy & Kapoor, 2010; Rengma et al., 2015; Sen et al., 2013; Subramanian et al., 2007). Several researchers have described rising prevalence of obesity as an age-related effect among the female population (Rengma et al., 2015; Sen et al., 2013; Subramanian et al., 2007).

This makes it necessary to assess the prevalence of double burden of malnutrition (DBM). Such monitoring needs to be based on the sociocultural and environmental factors that determine the prevalence of underweight and overweight (Biernat & Tomaszewski 2015; Rengma et al., 2015; Sen et al., 2013). Several socioeconomic and demographic factors can influence the prevalence of overweight and obesity in Indian populations (Mondal et al., 2017; Mungreiphy & Kapoor, 2010; Subramanian et al., 2007). Recent socioeconomic transitions are responsible for rises in non-communicable diseases, overweight and obesity (Popkin, 2012; Wang et al., 2009). The present study reveals that many socioeconomic and demographic indicators such as age, birth weight of children, type of fuel for cooking, bath place, sources of drinking water, husband's occupation and family income all are associated with the double burden of malnutrition. This is similar to previous findings (Guevara-Romero et al., 2022; Monteiro et al., 2004; Neuman et al., 2013).

Several research investigations have shown relationships of different socioeconomic and demographic factors with the nutritional status of adult women in India (Bharali et al., 2017; Mondal et al., 2017; Mungreiphy & Kapoor, 2010; Rengma et al., 2015; Sen et al., 2013; Subramanian & Smith, 2006; Subramanian et al., 2007; Tigga et al., 2018; Venkatramanan et al., 2017; Waghmare et al., 2022). Population-specific associations of socioeconomic and demographic factors with the prevalence of undernutrition, overweight and obesity were observed to be statistically significant also among the Rajbanshi and Namasudra women of the present study (Table 4). The multinomial analysis reveals that socioeconomic demographic factors significantly influence the BMI among women. Age and source of drinking water are associated with the double burden of malnutrition supporting the results of a previous study (Waghmare et al., 2022). An association of income was reported (Venkatramanan et al., 2017; Tigga et al., 2018). Occupational status has shown a significant association with undernutrition in previous studies (Mugreiphy & Kapoor 2010; Sen et al., 2013). The risk of combined adiposity (overweight + obesity), as defined by BMI $\geq$ 23 kg/m^2, was significantly lower in middle-aged women (25-30 years) than in older women (Table 5).

Studies have reported that in lower-middle-income countries economic development has led to significant

changes and the replacement of traditional foods in diets with high-calorie and fat-containing food, along with processed food (Bose et al., 2021; Debnath et al., 2018; Kosaka & Umezaki, 2017; Temponi & Melendez, 2020). The present findings indicate that the positive relationship between income level and overnutrition may be influenced by other factors. The shift in diet towards high energy density and low micronutrient intakes, coupled with a sedentary lifestyle, has contributed to the household double burden of malnutrition among underweight (BMI < 18.5 kg/m^2) and overweight (BMI > 23 kg/m^2) women. The rise in household income has shifted the burden of overweight or obesity progressively from the wealthy to the poorer groups in India (Subramanian et al., 2007). In many developing countries undernutrition is still considered the main problem, even when the proportion of the overweight population exceeds that of the underweight (Mendez et al., 2005). In India, eradicating undernutrition is still an unfinished agenda. Despite this, India experienced a rising proportion of overweight adult women over the past few decades (Deaton & Dreze, 2009; IIPS Macro International, 2007). Research supported the conclusion that India was about to go through this transition (Sengupta et al., 2014).

The present investigation shows that the prevalence of underweight in our study populations is lower than that reported for most of the ethnic populations in India. Undernutrition was found to be marginally more prevalent in our Rajbanshi women than in previously studied Bengalee Kayastha, Nyishi, Karbi and Muslim women, but undernutrition among the Namasudra population was lower than that found in those previous studies. Conversely, the combined overweight-obesity prevalence of both Rajbanshi and Namasudra ethnicities was higher than that reported for Oraon, Bathudi, Bengali Muslim, Nyishi, Marwari, Karbi, Rengma Naga, and Bengalee Kayastha women.

Limitations of the present study are its cross-sectional nature, smallish sample size, and lack of information about dietary intake among the research participants. The consideration of socioeconomic demographic covariates may be helpful in policy formulation and implementation. There had previously been a dearth of information about socioeconomic and demographic determinants of double burden of malnutrition among Rajbanshi and Namasudra women of Jalpaiguri, West Bengal, India.

5 Conclusion

The present investigation suggests that undernutrition is still a cause for concern among both of the studied populations, although there is also much overweight and obesity. This study proves the existence of a double burden of malnutrition among Rajbanshi and Namasudra women. Intervention programs featuring awareness campaigns, physical activity, balanced diets, and age and gender sensitive programs should utilize people's socioeconomic and demographic profile to combat DBM among women. The findings of the present study might be helpful to government agencies for policy formulation. The issue of DBM among various populations must be addressed through research, public health policy, and nutritional education, specifically in the context of the nutritional transition. Awareness programs are essential to eradicate the double burden of malnutrition among ever-married women of the two studied ethnicities. Adequate nutritional knowledge and awareness at the community level could help to reduce future risks of undernutrition and overnutrition as a cause of morbidity and mortality also among other ethnic groups in India.

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References

Afshin, A. M. H., Reitsma, M. B., Sur, P., Estep, K. et al., (2017). Health effects of overweight and obesity in 195 countries over 25 years. *New England Journal of Medicine, 377*(1), 3-27.

Agrawal, P., Gupta, K., Mishra, V. & Agrawal, S. (2013). Effects of sedentary lifestyle and dietary habits on body mass index change among adult women in India: Findings from a follow-up study. *Ecology of Food and Nutrition, 52,* 387-406.

Arokiasamy, P., Uttamacharya, U., Jain, K., Biritwum, R. B., Yawson, A. E., Wu, F. & Kowal, P. (2015). The impact of multimorbidity on adult physical and mental health in low- and middle-income countries: What does the Study on Global Ageing and Adult Health (SAGE) reveal? *BMC Medicine, 13*(1), 1-16.

Bhandari, S., Sayami, J. T., Thapa, P., Sayami, M., Kandel, B. P. & Banjara, M. R. (2016). Dietary intake patterns and nutritional status of women of reproductive age in Nepal: Findings from a health survey. *Archives of Public Health, 74*(1), 1-11.

Bharali, N., Mondal, N. & Singh, K. N. (2017). Prevalence of undernutrition, overweight and obesity among Nyishi tribal women of Arunachal Pradesh, Northeast India. *Human Biology Review, 6*(1), 63-78.

Bhurosy, T. & Jeewon, R. (2014). Overweight and obesity epidemic in developing countries: A problem with diet, physical activity, or socioeconomic status? *Scientific World Journal, 1,* 964236.

Biernat, E. & Tomaszewski, P. (2015). Association of socio-economic and demographic factors with physical activity of males and females aged 20–69 years. *Annals of Agricultural and Environmental Medicine, 22*(1), 118-123.

Biswas, T., Garnett, S. P., Pervin, S. & Rawal, L. B. (2017). The prevalence of underweight, overweight and obesity in Bangladeshi adults: Data from a national survey. *PLoS One, 12*(5), e0177395.

Bose, A., Mondal, N. & Sen, J. (2021). Household levels of double burden of malnutrition in low–middle-income countries: A review. *Journal of the Anthropological Survey of India, 71*(1), 125-160. https://doi.org/10.1177/2277436X211043628.

Bose, K., Chakraborty, F., Bisai, S., Khatun, A. & Bauri, H. (2006). Anthropometric characteristics and nutritional status based on body mass index of adult Bathudis: A tribal population of Keonjhar District, Orissa, India. *Asia Pacific Journal of Clinical Nutrition, 14*(1), 80-82.

Census of India (2011). https://censusindia.gov.in

Das, M. & Bose, K. (2006). Presence of high rates of overweight and obesity among adult Marwaris of Howrah, West Bengal, India. *Collegium Anthropologicum, 30*(1), 81-86.

Datta Banik, S., Bhattacharjee, P., Das, S., Barman, R. K., Das, S., Giri, S. P. & Purkait, P. (2009). 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. *Journal of Life Sciences, 1*(1), 27-34.

Datta Banik, S., Bose, K., Bisai, S., Bhattacharya, M., Das, S., Jana, A. & Purkait, P. (2007). Undernutrition among adult Dhimals of Naxalbari, West Bengal: Comparison with other tribes of eastern India. *Food and Nutrition Bulletin, 28*(3), 348-352.

Deaton, A. & Dreze, J. (2009). Food and nutrition in India: Facts and interpretations. *Economic and Political Weekly, 44*(7), 42-65.

Debnath, S. (2020). *Child, maternal body composition and nutritional status among the Bengali Muslim population of Darjeeling district, West Bengal*. Doctoral dissertation, University of North Bengal.

Debnath, S., Bhowmik, S. & Sen J. (2019). Double burden of malnutrition among Bengalee Kayastha women of Siliguri town, Darjeeling district, West Bengal, India. *Human Biology Review, 8*(4), 367-380.

Debnath, S., Mondal, N. & Sen, J. (2018). Socio-economic and demographic correlates of stunting and thinness among rural school-going children (aged 5–12 years) of North Bengal, Eastern India. *Journal of Life Science, 10*(1), 14-31.

Dinsa, G. D., Goryakin, Y., Fumagalli, E. & Suhrcke, M. (2012). Obesity and socioeconomic status in developing countries: A systematic review. *Obesity Review, 13*(11), 1067-1079.

Doku, D. T. & Neupane, S. (2015). Double burden of malnutrition: Increasing overweight and obesity and stall underweight trends among Ghanaian women. *BMC Public Health, 15*(1), 1-9.

Dutta, M., Selvamani, Y., Singh, P. & Prashad, L. (2019). The double burden of malnutrition among adults in India: Evidence from the National Family Health Survey-4 (2015-16). *Epidemiology and Health, 41*, e2019050.

Gogoi, G. & Sengupta, S. (2002). Body mass index among the Dibongiya Deoris of Assam, India. *Journal of Human Ecology, 13*(4), 271-273.

Guevara-Romero, E., Flórez-García, V., Egede, L. E. & Yan, A. (2022). Factors associated with the double burden of malnutrition at the household level: A scoping review. *Critical Reviews in Food Science and Nutrition, 62*(25), 6961-6972.

Hanandita, W. & Tampubolon, G. (2015). The double burden of malnutrition in Indonesia: Social determinants and geographical variations. *SSM-Population Health, 1,* 16-25.

Hossain, P., Kawar, B. & El Nahas, M. (2007). Obesity and diabetes in the developing world—a growing challenge. *New England Journal of Medicine, 356*(3), 213-215.

IIPS and Macro International (2007). *National Family Health Survey-3 Report (2005–06)*. Mumbai: IIPS.

Kamal, S. M. & Islam, A. (2010). Socio-economic correlates of malnutrition among married women in Bangladesh. *Malaysian Journal of Nutrition, 16*(3), 349-359.

Kapoor, S. K. & Anand, K. (2002). Nutritional transition: A public health challenge in developing countries. *Journal of Epidemiology & Community Health, 56*(11), 804-805.

Khan, N. C. & Khoi, H. H. (2008). Double burden of malnutrition: The Vietnamese perspective. *Asia Pacific Journal of Clinical Nutrition, 17,* 116-118.

Khongsdier, R. (2001). Body mass index of adult males in 12 populations of Northeast India. *Annals of Human Biology, 28*(4), 374-383.

Kosaka, S. & Umezaki, M. (2017). A systematic review of the prevalence and predictors of the double burden of malnutrition within households. *British Journal of Nutrition, 117*(8), 1118-1127.

Kshatriya, G. K. & Acharya, S. K. (2016). Gender disparities in the prevalence of undernutrition and the higher risk among the young women of Indian tribes. *PLoS One, 11*(7), e0158308.

Kulkarni, V. S., Kulkarni, V. S. & Gaiha, R. (2017). "Double burden of malnutrition". Reexamining the coexistence of undernutrition and overweight among women in India. *International Journal of Health Services*, *47*(1), 108-133.

Letamo, G. & Navaneetham, K. (2014). Prevalence and determinants of adult under-nutrition in Botswana. *PLoS One, 9*(7), e102675.

Mendez, M. A., Monteiro, C. A. & Popkin, B. M. (2005). Overweight exceeds underweight among women in most developing countries. *American Journal of Clinical Nutrition, 81,* 714-721.

Mondal, N., Timungpi, R., Sen, J. & Bose, K. (2017). Socio-economic and demographic correlates of overweight and obesity: A study on the Karbi women of Assam, Northeast India. *Anthropology Open Journal, 2*(2), 31-39.

Monteiro, C. A., Moura, E. C., Conde, W. L. & Popkin, B. M. (2004). Socioeconomic status and obesity in adult populations of developing countries: A review. *Bulletin of the World Health Organization, 82,* 940-946.

Mungreiphy, N. K. & Kapoor, S. (2010). Socioeconomic changes as covariates of overweight and obesity among Tangkhul Naga tribal women of Manipur, North-East India. *Journal of Biosocial Science, 42*(3), 289-305.

Neuman, M., Kawachi, I., Gortmaker, S. & Subramanian, S. V. (2013). Urban–rural differences in BMI in low- and middle-income countries: The role of socioeconomic status. *American Journal of Clinical*

Nutrition, 97(2), 428-436.

Oenema, S. (2019). Ten years to achieve transformational change: The United Nations Decade of Action on Nutrition 2016-2025. In B. Burlingame & S. Dernini (Eds.), *Sustainable Diets: Linking Nutrition and Food Systems* (pp. 261-267). Wallingford UK: CABI.

Pednekar, M. S., Hakama, M., Hebert, J. R. & Gupta, P. C. (2008). Association of body mass index with all-cause and cause-specific mortality: Findings from a prospective cohort study in Mumbai (Bombay), India. *International Journal of Epidemiology, 37,* 524-535.

Popkin, B. M., Adair, L. S. & Ng, S. W. (2012). Global nutrition transition and the pandemic of obesity in developing countries. *Nutrition Reviews, 70*(1), 3-21.

Prabhakaran, D., Jeemon, P., Sharma, M., Roth, G. A., Johnson, C., Harikrishnan, S., ... & Dandona, L. (2018). The changing patterns of cardiovascular diseases and their risk factors in the states of India: The Global Burden of Disease Study 1990–2016. *Lancet Global Health, 6*(12), e1339-e1351.

Rengma, M. S., Sen, J. & Mondal, N. (2015). Socio-economic, demographic and lifestyle determinants of overweight and obesity among adults of Northeast India. *Ethiopian Journal of Health Sciences, 25*(3), 199-208.

Risley, H. H. (1892). *The Tribes and Castes of Bengal* (Vol. 1). Bengal Secretariat Press.

Roskam, A. J., Kunst, A. E., van Oyen, H., Demarest, S., Klumbiene, J., Regidor, E., et al. (2010). Comparative appraisal of educational inequalities in overweight and obesity among adults in 19 European countries. *International Journal of Epidemiology, 39,* 392-404.

Selvamani, Y. & Singh, P. (2018). Socioeconomic patterns of underweight and its association with self-rated health, cognition and quality of life among older adults in India. *PLoS One, 13,* e0193979.

Sen, J., Mondal, N. & Dutta, S. (2013). Factors affecting overweight and obesity among urban adults: A cross-sectional study. *Epidemiology, Biostatistics, and Public Health, 10*(1), e8741-1.

Sengupta, A., Angeli, F., Syamala, T. S., van Schayck, C. P. & Dagnelie, P. (2014). 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? *Ecology of Food & Nutrition, 53*(6), 618-638. doi: 10.1080/03670244.2014.891994. PMID: 25357268.

Sharma, J. & Mondal, N. (2020). Nutritional status and health related issues among the rural women of Karbi Anglong, Assam (India). *Human Biology Review, 9*(2), 146-165.

Shrimpton, R. & Rokx, C. (2012). *The double burden of malnutrition: A review of global evidence*. Washington DC: World Bank.

Siddiqui, M. Z. & Donato, R. (2017). Undernutrition among adults in India: The significance of individual-level and contextual factors impacting on the likelihood of underweight across sub-populations. *Public Health Nutrition, 20*(1), 130-141.

Subramanian, S. V. & Smith, G. D. (2006). Patterns, distribution, and determinants of under- and overnutrition: A population-based study of women in India. *American Journal of Clinical Nutrition, 84,* 633-640.

Subramanian, S. V., Kawachi, I. & Smith, G. D. (2007). Income inequality and the double burden of under- and overnutrition in India. *Journal of Epidemiology & Community Health, 61*(9), 802-809.

Tan, K. C. B. (2004). Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet, 363*(9403), 157-163.

Temponi, H. R. & Venlasquez-Melendez, G. (2020). Prevalence of double burden of malnutrition at household level in four Latin American countries. *Revista Brasileira de Saúde Materno Infantil Recife, 20*(1), 27-35.

Tigga, P. L., Debnath, S., Das, M., Mondal, N. & Sen, J. (2018). Prevalence of undernutrition and overweight or obesity among the Bengali Muslim population of West Bengal, India. *Anthropology Open Journal, 3*(1), 1-10.

Tremmel, M., Gerdtham, U. G., Nilsson, P. M. & Saha, S. (2017). Economic burden of obesity: A systematic literature review. *International Journal of Environmental Research and Public Health, 14*(4), 435.

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

Waghmare, H., Mondal, N. A. & Prasad, R. D. (2022). Determinants of nutritional status among women in South Asian countries: A cross-sectional study. *Demography India, 51,* 100-110.

Wang, Y., Chen, H. J., Shaikh, S. & Mathur, P. (2009). Is obesity becoming a public health problem in India? Examine the shift from under- to overnutrition problems over time. *Obesity Reviews, 10*(4), 456-474.

Weiner, J. S. & Lourie, J. A. (1981). *Practical Human Biology*. Academic Press.

Whitlock, G., Lewington, S., Sherliker, P. & Peto, R. (2009). Body-mass index and mortality—Authors' reply. *Lancet*, *374*(9684), 114.

World Health Organization. (2011). Obesity and overweight. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight