CHAPTER 10

Body Mass Index and Chronic Energy Deficiency among Adult Tribal Populations of West Bengal: A Review

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INTRODUCTION

India remains one of the poorest countries in the world, with a population of over one billion and a fertility rate well above replacement level (World Bank 2000). Moreover, improvements in the nutritional status of the population during the last two to three decades have not been impressive (Griffiths and Bentley, 2001). More than half the world's undernourished populations live in India (Krishnaswami, 2000). In general, tribal populations of India are recognized as socially and economically vulnerable (Ghosh and Bharati, 2006). A recent report (NFHS-2, 2001) has stated that West Bengal had the highest rate of chronic energy deficiency (CED) among adult female tribals in India (NFHS-2, 2001).

As per latest census, India has more than 84 million tribals who constitute 8.2% of the total population (Mittal and Srivastava, 2006). India probably has the largest number of tribal communities in the world (Topal and Samal, 2001). The vast majority of the tribal populations reside in rural areas of the country. Traditionally, some of them were forest dwellers but now they have started cultivation either as owner or as agricultural labourers and are also engaged in hunting and fishing. In West Bengal, more than 80% of them follow Hinduism with their traditional belief in sprits and nature (Mandal et al., 2002). They take part in all the religious festivals of the Hindus in West Bengal (Mandal et al., 2002).

World Health Organization (1995) has recommended that anthropometry could be used to assess the nutritional and health status of adults. One such measure now in widespread use is Quetelet's index, which is body weight (in kg) divided by stature (in m^2) (Keys et al., 1972). Better known as body mass index (BMI), this measure was an attempt by the 19th century mathematician Lambert Adolphe Jacques Quetelet to describe the relation between body weight and stature in humans (Quetelet, 1842). Many studies have shown that BMI is a reasonable measure of adiposity (Keys et al., 1972, Khosla and Lowe 1967, Garrow and Webster 1985, Smalley et al 1990, Deurenberg et al., 1991, Strain and Zumoff, 1991; Bose, 1996). Low BMI and high levels of undernutrition (based on BMI) is a major public health problem especially among rural underprivileged adults of developing countries (WHO, 1995). Although adult nutritional status can be evaluated in many ways, the BMI is most widely used because its use is simple, inexpensive, safe and suitable for large-scale surveys (Lohman et al., 1988; Ferro-Luzzi et al., 1992; James et al., 1994; Lee and Nieman, 2003). Thus, BMI is the most established anthropometric indicator used for assessment of adult nutrition status (Lee and Nieman, 2003).

BMI is generally considered a good indicator of not only the nutritional status but also the socio-economic condition of a population, especially adult populations of developing countries (Ferro-Luzzi et al., 1992; Shetty and James, 1994; Nube et al., 1998; Khongsdier, 2002; Mosha, 2003). A BMI < 18.5 kg/m^2 is widely used as a practical measure of chronic energy or hunger deficiency (CED), i.e., a 'steady' underweight in which an individual is in energy balance irrespective of a loss in body weight or body energy stores (Khongsdier, 2005). Such a 'steady' underweight is likely to be associated with morbidity or other physiological and functional impairments (James et al., 1988; Shetty and James, 1994; WHO, 1995). CED is caused by inadequate intake of energy accompanied by high level of physical activities and infections (Shetty and James, 1994; Shetty et al., 1994). It is associated with reduced work capacity (Pryer, 1993; Durnin, 1994), performance and productivity (Kennedy and Garcia, 1994), increased morbidity due to suppressed immune function (Garcia and Kennedy, 1994; Shetty and James, 1994; Strickland and Ulijaszek, 1994) and behavioural changes (Kusin et al., 1994).

It well established that undernourished women are more prone to have low birth weight (weight at birth <2.5 kg) babies (Kramer, 1987; Bisai, 2004) and to have adverse pregnancy outcome (Baird, 1947). Birth weight is an

important parameter, which could be indicative of the immediate viability of the neonate and the state of maternal health and nutrition during pregnancy (Gopalan, 1996). The survival of infants and their postnatal growth and development largely depend on birth weight (WHO, 1984). Women among developing countries like India are undernourished (Samuel et al., 1992), and their dietary energy intake is not adequate to compensate their heavy physical workload. In these countries most women were found to weigh below the 55 kg norm used by world health organization. For instance data from several studies in Asian and African countries reported the average weight of nonpregnant and non-lactating young women to be in the range of 40-50 kg (Kisanga, 1990).

Data are scanty on the anthropometric and nutritional status of various tribal populations of India (Arlappa et al., 2005; Bose and Chakraborty, 2005, Bose et al., 2006a; b; c; d; Ghosh and Bala, 2006). It has been recently suggested (Bose and Chakraborty, 2005) that there is urgent need to evaluate the nutritional status of various tribes of India. The objective of the present study was to review the existing recent published and unpublished work on the nutritional status (assessed by BMI) of adult tribal populations of West Bengal.

METHODS

The aim of literature review is to critically analyze studies and synthesize research findings into conclusions regarding the current level of knowledge on the topic. The implications of the findings are discussed and recommendations for further research from the public health perspective have been formulated.

Relevant published articles were identified by performing computerized literature searches of the PUBMED, YAHOO, GOOGLE and INDMED databases from 2005 to 2007 using the key words; height, weight, body mass index, BMI, Tribes, Tribals, Adult, Undernutrition, West Bengal and India. Potential studies for review were selected from published English language research studies that reported mean BMI and CED (based on BMI) by sex specific and community specific data on tribals of West Bengal. Ancestry searches of the reference lists of published studies and related articles were also used to identify relevant studies. The criteria for inclusion of a research report in this review included the following: published and unpublished report of original research in English; data specific to tribe reported; and the differences between BMI and undernutrition by sex with at least one measure of central tendency such as the mean or median. A total of ten studies were found. Of these, nine studies met the criteria for inclusion in this review of the literature and were analyzed by using the procedures described below.

BMI was computed using the following standard equation:

$$BMI = \text{Weight (kg)} / \text{height (m}^2\text{)}$$

Nutritional status was evaluated using internationally accepted BMI guidelines (WHO, 1995). The following cut-off points were used:

CED BMI <18.5
Normal: BMI = 18.5 – 24.9
Overweight: BMI ≥ 25.0

We followed the World Health Organization's classification (1995) of the public health problem of low BMI, based on adult populations worldwide. This classification categorises prevalence according to percentage of a population with BMI < 18.5.

1) Low (5–9%): warning sign, monitoring required.
2) Medium (10–19%): poor situation.
3) High (20–39%): serious situation.
4) Very high (≥ 40%): critical situation.

Student's t-tests were performed to test for sex differences in mean BMI. Sex differences in CED/non CED were determined by chi-square test. All statistical analyses were undertaken using the SPSS Statistical Package. Statistical significance was set at $p < 0.05$.

RESULTS

The sample sizes in the 9 studies reviewed varied from 87 to 400. The ages of the studied varied from 18 to 85 years. Most studies included individuals from a wide range of ages, but two studies focused specifically on 20-45 years and 18-60 years. The majority of studies (n = 4) were of four tribal communities (Bhumij, Kora-Mudi, Lodha, Santal) from the Paschim Medinipur District. Two studies analyzed data gathered from Bankura District (Kora-Mudi, Santal), one study presented data from a periurban area of Kolkata, one study was on Oraons from New Mal subdivision of Jalpaiguri District. The last study

was of Dhimal tribe from Darjeeling District.

Table 1 and 2 present the mean age, height and weight of the study subjects. Mean BMI and the levels of CED (among males) of the various tribal populations of West Bengal were shown in Table 3. From this table it can be inferred that, in general, the mean BMI of the tribes of West Bengal was in the range of 18.5-20.0 kg/m^2. Moreover, the rates of CED varied between 27.0% and 55.0%. These rates were in the category high (20–39%) to very high (≥40%). These results clearly indicated that, males of these tribes were under serious or critical nutritional stress.

Table 4 presents the mean BMI and the levels of CED (among females) of the various tribal

Table 1: Mean age, height and weight among adult tribal males of West Bengal.

Tribe	*Sam-ple Size*	*Age (yrs)*	*Hei-ght (cm)*	*Wei-ght (kg)*	*Study Area*	*Ref-erence*
Bhumij	161	36.3	159.4	47.4	Paschim Medinipur	Ghosh, (2007)
Dhimal	159	35.9	163.3	52.2	Darjeeling	Datta Banik et al. (2007)
Kora Mudi	250	32.7*	159.1*	46.8*	Bankura	Bose et al. (2006b)
Kora Mudi	87	35.3	162.1	48.9	Paschim Medinipur	Bisai et al. (2008)
Lodha	157	39.0	161.4	50.8	Paschim Medinipur	Mondal (2007)
Munda	153	18-60	162.4	49.4	Kolkata	Ghosh & Bharati (2006)
Oraon	200	20-45	158.0	47.0	Jalpaiguri	Mittal & Srivastava (2006)
Santal	197	35.0	160.5	51.7	Paschim Medinipur	Bose et al. (2006c)
Santal	400	57.5	159.8	47.2	Bankura	Ghosh & Malik (2007)

* Values are median

populations of West Bengal. From this table it can be inferred that, in general, the mean BMI of the tribes of West Bengal was in the range 17.7-19.7 kg/m^2. Moreover, the rates of CED varied between 31.7% and 61.8%. These rates were in the category high (20–39%) to very high (≥40%). These results clearly indicated that, females of these tribes were under serious or critical nutritional stress.

Table 5 presents the mean BMI and the levels of CED (among tribal females) of the various

Table 2: Mean age, height and weight among adult tribal females of West Bengal.

Tribe	*Sam-ple Size*	*Age (yrs)*	*Hei-ght (cm)*	*Wei-ght (kg)*	*Study Area*	*Ref-erence*
Bhumij	185	33.8	148.4	40.5	Paschim Medinipur	Biswas (2007)
Dhimal	146	32.8	152.4	44.6	Darjeeling	Datta Banik et al. (2007)
Kora Mudi	250	31.7*	147.5*	39.5*	Bankura	Bose et al. (2006b)
Kora Mudi	123	34.8	149.3	40.9	Paschim Medinipur	Bisai et al. (2007)
Lodha	199	34.4	149.2	42.9	Paschim Medinipur	Adhikary (2007)
Munda	234	18-60	149.6	39.8	Kolkata	Ghosh & Bharati (2006)
Oraon	150	20-45	144.0	41.0	Jalpaiguri	Mittal & Srivastava (2006)
Santal	213	35.6	149.8	43.4	Paschim Medinipur	Bose et al. (2006c)
Santal	400	48.6	148.9	41.4	Bankura	Ghosh & Malik (2007)

* Values are median

states of India. From this table it can be inferred that, in general, the mean BMI of the tribal females of various states of India was in the range 18.2-23.0 kg/m^2. Moreover, the rates of CED varied between 4.8 % (Sikkim) and 64.2% (West Bengal). These rates were in the category good (< 5%) and very high (≥40%). These results clearly indicated that, tribal females of West Bengal were under critical nutritional stress. The relationship between mean BMI and CED among female tribals in various states of India is presented in Figure1.

DISCUSSION AND RECOMMENDATIONS

Several recent studies from India (Yadav et al., 1999; Gogoi and Sengupta, 2002; Sahani, 2003; Bose and Chakraborty, 2005; Bose et al., 2006a) have utilized BMI to study nutritional status of tribal populations. Therefore, the use of BMI and WHO (1995) BMI-based cut-off points for the evaluation of CED are valid for use among tribal populations of India. Moreover, recent investigations (Datta Banik et al., 2007; Bose et al., 2006b; 2006c; Bisai et al., 2007; Ghosh and Bharati, 2006; Mittal and Srivastava, 2006; Ghosh and Malik, 2007; Ghosh, 2007; Biswas, 2007;

Table 3: Mean BMI and prevalence of CED (based on BMI) among adult tribal males of West Bengal.

Tribe	*n*	*Mean BMI*	*CED (%)*	*Nutritional Condition*	*Study Area*	*Reference*
Bhumij	161	18.7 (2.4)	48.4* [12.4]	Critical	Paschim Medinipur	Ghosh, (2007)
Dhimal	159	19.5 (2.0)	27.0* [2.5]	Serious	Darjeeling	Datta Banik et al. (2007)
Kora Mudi	250	18.7	48.0	Critical	Bankura	Bose et al. (2006b)
Kora Mudi	87	18.6 (1.9)	51.7	Critical	Paschim Medinipur	Bisai et al. (2008)
Lodha	157	19.5 (2.7)	45.2 [5.7]	Critical	Paschim Medinipur	Mondal (2007)
Munda	153	18.7^ (1.8)	49.0* [8.5]	Critical	Kolkata	Ghosh & Bharati (2006)
Oraon	200	18.8^ (2.0)	47.0* [6.0]	Critical	Jalpaiguri	Mittal & Srivastava (2006)
Santal	197	20.0^ (2.6)	31.5*	Serious	Paschim Medinipur	Bose et al. (2006c)
Santal	400	18.5**	55.0	Critical	Bankura	Ghosh & Malik (2007)

n = Sample size.
^ Significant sex difference of mean BMI; p<0.05.
* Significant sex difference of undernutrition; p<0.05.
** BMI was calculated based on the reported weight and height.
() Presents standard deviation of the mean,
[] Presents percentage of CED grade III (BMI<16.0).

Table 5: Mean BMI and prevalence of CED (based on BMI) among tribal females aged 15-49 years in various states of India.

States	*Sample Size*	*Mean BMI*	*CED (%)*	*Nutritional condition*
India	6590	19.1	46.3	Critical
Andhra Pradesh	182	19.1	44.2	Critical
Assam	609	20.4	19.1	Serious
Bihar	514	19.2	41.0	Critical
Chhattisgarh	302	18.5	55.2	Critical
Gujarat	671	19.0	55.0	Critical
Jammu & Kashmir	64	19.4	43.4	Critical
Jharkhand	414	19.1	40.9	Critical
Karnataka	226	18.9	49.0	Critical
Madhya Pradesh	1353	18.8	49.2	Critical
Maharastra	489	18.9	54.8	Critical
Orissa	796	18.5	55.5	Critical
Rajasthan	676	19.2	39.6	Critical
Sikkim	262	23.0	4.8	Good
Uttar Pradesh	118	19.7	32.6	Serious
West Bengal	287	18.2	64.2	Super Critical

Source: National Family Health Survey – 2 (2001).

Mondal, 2007; Adhikary, 2007) have studied the anthropometric characteristics and levels of undernutrition among various tribal populations

Table 4: Mean BMI and prevalence of CED (based on BMI) among adult tribal females of West Bengal.

Tribe	*n*	*Mean BMI*	*CED (%)*	*Nutritional Condition*	*Study Area*	*Reference*
Bhumij	185	18.4 (2.9)	58.9* [17.8]	Critical	Paschim Medinipur	Biswas (2007)
Dhimal	146	19.1 (2.6)	46.4* [8.2]	Critical	Darjeeling	Datta Banik et al. (2007)
Kora Mudi	250	18.3	56.4	Critical	Bankura	Bose et al. (2006b)
Kora Mudi	123	18.3 (2.1)	55.3	Critical	Paschim Medinipur	Bisai et al. (2008)
Lodha	199	19.3 (2.6)	40.7 [7.0]	Critical	Paschim Medinipur	Adhikary (2007)
Munda	234	17.7^ (1.8)	67.9* [16.7]	Critical	Kolkata	Ghosh & Bharati (2006)
Oraon	150	19.7^ (2.4)	31.7* [5.4]	Serious	Jalpaiguri	Mittal & Srivastava (2006)
Santal	213	19.3^ (2.6)	41.8*	Critical	Paschim Medinipur	Bose et al. (2006c)
Santal	400	18.7**	52.5	Critical	Bankura	Ghosh & Malik (2007)

n = Sample size.
^ Significant sex difference of mean BMI; p<0.05.
* Significant sex difference of undernutrition; p<0.05.
** BMI was calculated based on the reported weight and height.
() Presents standard deviation of the mean.
[] Presents percentage of CED grade III (BMI<16.0).

of West Bengal. These studies have dealt with Bhumijs (Ghosh, 2007; Biswas, 2007), Dhimals, (Datta Banik et al. 2007), Kora Mudis (Bose et al., 2006b; Bisai et al., 2007), Lodhas (Mondal, 2007; Adhikary, 2007), Mundas (Ghosh, and Bharati, 2006), Oraons (Mittal and Srivastava, 2006) and Santals (Bose et al., 2006c; Ghosh and Malik, 2007).

Another anthropometric measure that can be used to evaluate adult nutritional status is the mid-upper-arm circumference (MUAC). It has been shown that the MUAC is particularly effective for the determination of malnutrition among adults in developing countries (James et al., 1994). MUAC is a simpler measure than BMI, requiring a minimum of equipment, and in practice has now been found to predict morbidity and mortality as accurately as deficits in weight (Briend et al., 1989). In a recent study on adult

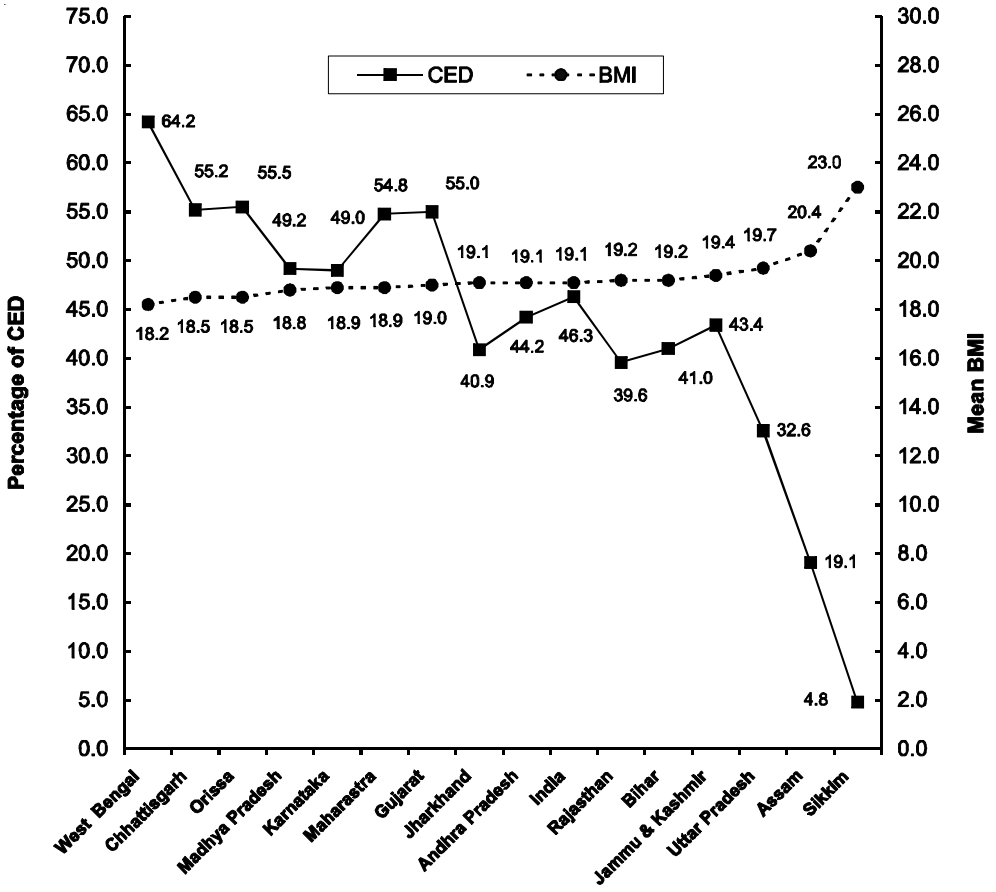

Fig. 1. CED among female tribals in various states of India.

Santal men of Orissa, Bose et al., (2006e) found that the use of MUAC may be preferred, since many individuals who would be classified as having CED on the basis of MUAC may not be classified as having CED when BMI is used as a measure of CED. Thus, the target group for intervention would be reduced if BMI were used. Furthermore, with limited resources and in the absence of skilled personnel, it may be more appropriate to use MUAC for population surveys.

Of primary importance, from the public health perspective, is the need for immediate nutritional intervention programs to be implemented among all these ethnic groups. The Indian Government should play an active role in reducing the rates of undernutrition among tribal people. Although priority must be given to tribal groups having the highest rates of undernutrition, all groups must be incorporated in these food supplementation programs. It is imperative that the recommendations should include not only adequate dietary intake but also various ways in which they can enhance their socio-economic status through improved education and employment opportunities. It is expected that better educational attainment will lead to more scope for employment and healthier dietary practices. It is here that relevant government authorities should play a proactive role in reducing the rates of undernutrition among tribals. It has already been emphasized (Topal and Samal, 2001) that there exists variation in social and economic conditions among tribes of India. This variation must be taken into account before tribal-specific intervention programmes are formulated and initiated.

Lastly, since nutritional status is intricately linked with dietary habits as well as the ecology of the population, further research should be undertaken to investigate, in details, these factors. Each tribal population has its unique food habits (Mandal et al., 2002). Moreover, there are distinct inter-tribal differences in the environment in which they reside, i.e. ecology of the population (Mandal et al., 2002). The studies reviewed here did not deal with these factors as they were beyond the scope of study. These are limitations which must be addressed in future studies. Therefore, it is imperative that future studies on tribal populations include these parameters when investigating their nutritional status.

In conclusion, this review provided strong evidence that, in general, tribal populations of West Bengal were experiencing serious or critical nutritional stress. Immediate appropriate nutritional intervention programs are needed for implementation among these ethnic groups.

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KEYWORDS Body mass index; nutritional status; tribes; chronic energy deficiency

ABSTRACT This paper reviews the status of undernutrition or chronic energy deficiency (CED) among tribals of West Bengal. A comparison is also made with tribal females of other parts of India. This review provided strong evidence that, in general, tribal populations of West Bengal were experiencing serious or critical nutritional stress. Immediate appropriate nutritional intervention programs are needed for implementation among these ethnic groups.

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