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# Body Mass Index and Chronic Energy Deficiency among Adult Santals of Purulia District, West Bengal, India.

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**Abstracts**

The present community based cross-sectional study was undertaken to determine the overall prevalence of undernutrition using BMI (kg/m$^2$) among adult Santal tribals of Purulia District, West Bengal, India. Our study measured data on height and weight of adults aged 18 years and above from 10 villages of Purulia District. A total of 513 (196 males and 317 females) adults aged 18 years and above were measured. One commonly used indicator i.e., BMI was used to evaluate the nutritional status of the subjects. Based on BMI, chronic energy deficiency (CED) was used as a measure of undernutrition. Females were found to be more undernourished than their male counterparts (30.6%) & (63.4%). This sex difference was statistically highly significant ($x^2 = 55.96$; df = 4; $p < 0.001$). Our study demonstrated that Santals of Purulia, both males as well as females, were under nutritional stress. In general, tribes of West Bengal were experiencing serious to critical nutritional deficit. Urgent government attention is required to rectify this nutritional problem.

**Keywords:** Purulia; Santal, body mass index, chronic energy deficiency, gender differences.

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Das, S., Bose, K. (2010). Body Mass Index and Chronic Energy Deficiency among Adult Santals of Purulia District, West Bengal, India. *International Journal of Human Sciences* [Online]. 7:2. Available: http://www.insanbilimleri.com/en

## 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). 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.

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 laborers 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). A low BMI and high level 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).

Das, S., Bose, K. (2010). Body Mass Index and Chronic Energy Deficiency among Adult Santals of Purulia District, West Bengal, India. *International Journal of Human Sciences* [Online]. 7:2. Available: http://www.insanbilimleri.com/en

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 behavioral changes (Kusin et ai., 1994).

It is 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 the World Health Organization. For example, data from several studies in Asian and African countries reported the average weight of non-pregnant and non-lactating young women to be in the range of 40-50 kg (Kisanga, 1990).

Hitherto, 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 is evaluate the nutritional status of the adult Santals of Purulia and to compare the findings with the existing recent published and

Das, S., Bose, K. (2010). Body Mass Index and Chronic Energy Deficiency among Adult Santals of Purulia District, West Bengal, India. *International Journal of Human Sciences* [Online]. 7:2. Available: http://www.insanbilimleri.com/en

unpublished work on the nutritional status (assessed by BMI) of adult tribal populations of West Bengal.

## Materials and Methods

Our study was community based, cross-sectional study conducted in ten different villages of Purulia District, that are situated about 250 km from Kolkata, the capital of West Bengal, India. This study was carried out from December, 2009 to January 2010. A total of 513 (196 males and 317 females) above 18 years were measured. Data were collected after obtaining the necessary approval from the villagers; participants were informed about the objectives before the commencement of measurements. Information on age, gender, weight and height were collected on a pre-tested questionnaire by house-to-house visit following interview and examination. Height and weight measurements were taken on each subject by the first author following the standard techniques. (Lohman *et al.* 1988). According to the 2001 census, the district contains population of 25,36,516 of whom 12,98,078 are males and 12,38,438 are females out of whom 19.35% are Scheduled Castes and 19.22% are Scheduled Tribes. The literacy rates of males and females are 74.18% and 37.15%, respectively, of the total population. Purulia district is having second highest percentage of tribal population (18.3%) after Jalpaiguri (18.9%) in West Bengal. Some of the major tribes of Purulia district are Santals, Bhumijs, Kherias and Shabars. Among them, Santals consist of the highest population concentration in the district. According to the report of West Bengal Scheduled Castes and Tribes Facts and Information, Special Series No. 32, 1989, Santals, among all the tribal communities of Purulia district, comprise 62.66%. Tribal societies of Purulia are having distinct characteristics, where most of them are of Proto-Australoids groups with dark skin colour, sunken nose and lower forehead. As far as linguistic affiliation is concerned the languages spoken by the tribes in Purulia district are mostly from Austro-Asiatic family where people belonging to Munda branch speak Santhali, Gondi, and Kheria.

Purulia district, a part of the Chhotanagpur Plateau in India constitutes an area of particularly low agricultural productivity and a high incidence and severity of poverty. Moreover, the incidence of poverty among rural households in the Chhotanagpur Plateau is estimated to be among the highest in Asia. The district of Purulia is the westernmost district of West Bengal, girdled by the Tropic of Cancer, and its latitudinal and

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longitudinal extents are from 22°42´35´´ to 23°42´00´´North and from 85°49´25´´ to 86°54´37´´East respectively. Purulia has its boundaries on the east with Paschim Medinipur and Bankura districts of West Bengal; on the north with Bardhaman district of West Bengal; on the north- west, west and south- west with Jharkhand state. The total geographical area of the district is 6259 sq. kms (Census 2001), out of which the urban and rural areas consist of 79.37 sq. kms (1.27%) (Municipalities & Non-Municipalities) and 6179.63 sq. kms (98.73%), respectively.

The BMI was computed using the following standard equation:

BMI = Weight (kg) / height ($m^2$).

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

CED was further divided into CED III, CED II and CED I as BMI < 16.0, 16.0-16.9 and 17.0-18.4 $kg/m^2$, respectively.

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.

Low (5-9%): warning sign, monitoring required.

Medium (10-19%): poor situation.

High (20-39%): serious situation.

Very high (≥ 40%): critical situation.

Student's t-tests were performed to test for sex differences in mean BMI. Sex differences in CED were determined by chi-square test. Impact of age & $age^2$ on BMI were determined by bivariate correlation (r). All statistical analyses were undertaken using the SPSS Statistical Package. Statistical significance was set at $p < 0.05$.

## Results

The mean & standard deviation of age among males and females were 38.48 years (17.17) and 37.64 years (5.96). Thus both sexes had similar mean ages. Table 1 presents the mean weight, height and BMI of the study subjects.

Das, S., Bose, K. (2010). Body Mass Index and Chronic Energy Deficiency among Adult Santals of Purulia District, West Bengal, India. *International Journal of Human Sciences* [Online]. 7:2. Available: http://www.insanbilimleri.com/en

The prevalence of CED (among males and females) of the Santals of Purulia, West Bengal, is shown in Table 2. From this table it can be inferred that, in general, the females were highly energy deficient than their male counterpart; females have CED (Gd-III = 14.51, Gd-II = 16.40, Gd-I = 32.49) then males (Gd-III = 5.61, Gd-II = 4.59, Gd-I = 20.41). There was a highly significant difference between sexes in CED prevalence ($x^2$= 55.96; df = 4; $p < 0.001$).

**Table 1: Mean (SD) and t-test of anthropometrics of adult Santals of Purulia, West Bengal, India.**

| Variable | Men (n = 196) | Women (n = 317) | t |
|---|---|---|---|
| Weight (kg) | 49.59 (8.07) | 39.45 (5.96) | 16.32 * |
| Height (cm) | 158.95 (7.00) | 147.51 (5.7) | 20.20* |
| BMI (kg/m$^2$) | 19.54 (2.35) | 18.08 (2.21) | 7.01* |

$p < 0.001$.

**Table 2: Prevalence of CED among the subjects.**

| Sex | CED-I | CED-II | CED-III |
|---|---|---|---|
| Male | 11 (5.61) | 9 (4.59) | 40 (20.41) |
| Female | 46 (14.51) | 52 (16.40) | 103 (32.49) |

Figures in parentheses indicate percentages.
Chi-square = 55.96; df = 4; $p < 0.001$.

BMI was highly negatively significantly correlated with age and age$^{2.}$ With the increase in age, BMI decreased in both sexes (male r = -0.153*; female r = -0.167**). Similar findings with age$^2$ (male r = -0.180*; female r = -0.190*) were observed. The sex combined correlation with age and age$^2$ were -0.147** & -0.167**, respectively.

Das, S., Bose, K. (2010). Body Mass Index and Chronic Energy Deficiency among Adult Santals of Purulia District, West Bengal, India. *International Journal of Human Sciences* [Online]. 7:2. Available: http://www.insanbilimleri.com/en

## Discussion

Tables 3 and 4 present the mean age, height and weight of the studied population as well as the other tribal populations of West Bengal. It is clear from table 3 that Santal males of Purulia (159.0 cm) were shorter than others, except Oraons. Table 4 shows that Santal females were shorter (147.5 cm) except Oraons and lighter (39.5 kg - similar with Kora Mudis, Bankura).

**Table 3: Mean age, height and weight among adult tribal males of West Bengal.**

| Tribe | n | Age (yrs) | Height (cm) | Weight (kg) | Study Area | Reference |
|---|---|---|---|---|---|---|
| Bhumij | 161 | 36.3 | 159.4 | 47.4 | Paschim Medinipur | Ghosh, (2007) |
| Dhimal | 159 | 35.9 | 163.3 | 52.5 | 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 & Mallik (2007) |
| **Santal** | **196** | **38.48** | **159.0** | **49.6** | **Purulia** | **Present Study** |

*Values are median.

Comparisons of mean BMI and level of CED (among males) of the present study with various tribal population of West Bengal are shown in Table 5. From this table it can be inferred that, in general, Santal males of Purulia have higher mean BMI than others of the said state but BMI of the tribes of West Bengal was in the range of l8.5-20.0 kg/$m^2$. Moreover, the rate of CED among Santal males of our study was 30.6% while CED rates 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.

Das, S., Bose, K. (2010). Body Mass Index and Chronic Energy Deficiency among Adult Santals of Purulia District, West Bengal, India. *International Journal of Human Sciences* [Online]. 7:2. Available: http://www.insanbilimleri.com/en

Table 6 presents the mean BMI and the levels of CED of Santal females of Purulia and the various tribal populations (among females) of West Bengal. From this table it can be inferred that, in general, the mean BMI of Santal females of Purulia were low (18.1 kg/m$^2$) and CED rate indicated a critical situation. In the state of West Bengal, among tribal females, mean BMI was in the range 17.7 kg/m$^2$ to 19.7 kg/m$^2$. Moreover, the rates of CED varied between 31.7% and 67.9%. These rates were in the category high (20-39%) to very high (≥40%). These results clearly indicated that, Santa females of Purulia were in very critical situation and other tribes of West Bengal were under serious or critical nutritional stress.

**Table 4: Mean age, height and weight among adult tribal females of West Bengal.**

| Tribe | n | Age (yrs) | Height (cm) | Weight (kg) | Study Area | Reference |
|---|---|---|---|---|---|---|
| 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. (2008) |
| 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 & Mallik (2007) |
| **Santal** | **317** | **37.6** | **147.5** | **39.5** | **Purulia** | **Present Study** |

*Values are median.

The relationship between mean BMI and CED among Santal females and other female tribals in various states of India is presented in Figure 1. From this table it can be inferred that, in general, the mean BMI of Santals of Purulia was 63.4%. The tribal females of various states of India were 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.

Das, S., Bose, K. (2010). Body Mass Index and Chronic Energy Deficiency among Adult Santals of Purulia District, West Bengal, India. *International Journal of Human Sciences* [Online]. 7:2. Available: http://www.insanbilimleri.com/en

**Table 5: 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 (2.0) | 19.5 [2.5] | 27.0* | 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 & Mallik (2007) |
| **Santal** | **196** | **19.5 (2.4)** | **30.6*** ** | **Serious** | **Purulia** | **Present Study** |

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.
*** Significant sex difference of undernutrition; $p<0.001$.
() Presents standard deviation of the mean,
[] Presents percentage of CED grade III (BMI < 16.0).

According to National Family Health Statistics- 3 report (2006), the prevalence of undernutrition in India is 33.0% among males and 28.1% among females. In urban areas, these figures were 19.8% and 17.5%, respectively. In rural areas these were 38.8% and 33.1%, respectively. However, the situation is much worse in West Bengal with corresponding prevalence of 37.7% and 31.6%, respectively. Among urban males and females they were 19.9% and 15.5%, respectively. The corresponding rural figures were 44.9% (males) and 38.0% (females).

Das, S., Bose, K. (2010). Body Mass Index and Chronic Energy Deficiency among Adult Santals of Purulia District, West Bengal, India. *International Journal of Human Sciences* [Online]. 7:2. Available: http://www.insanbilimleri.com/en

**Table 6: Mean BMI and prevalence of CED (based on BMI) among adult tribal females of West Bengal.**

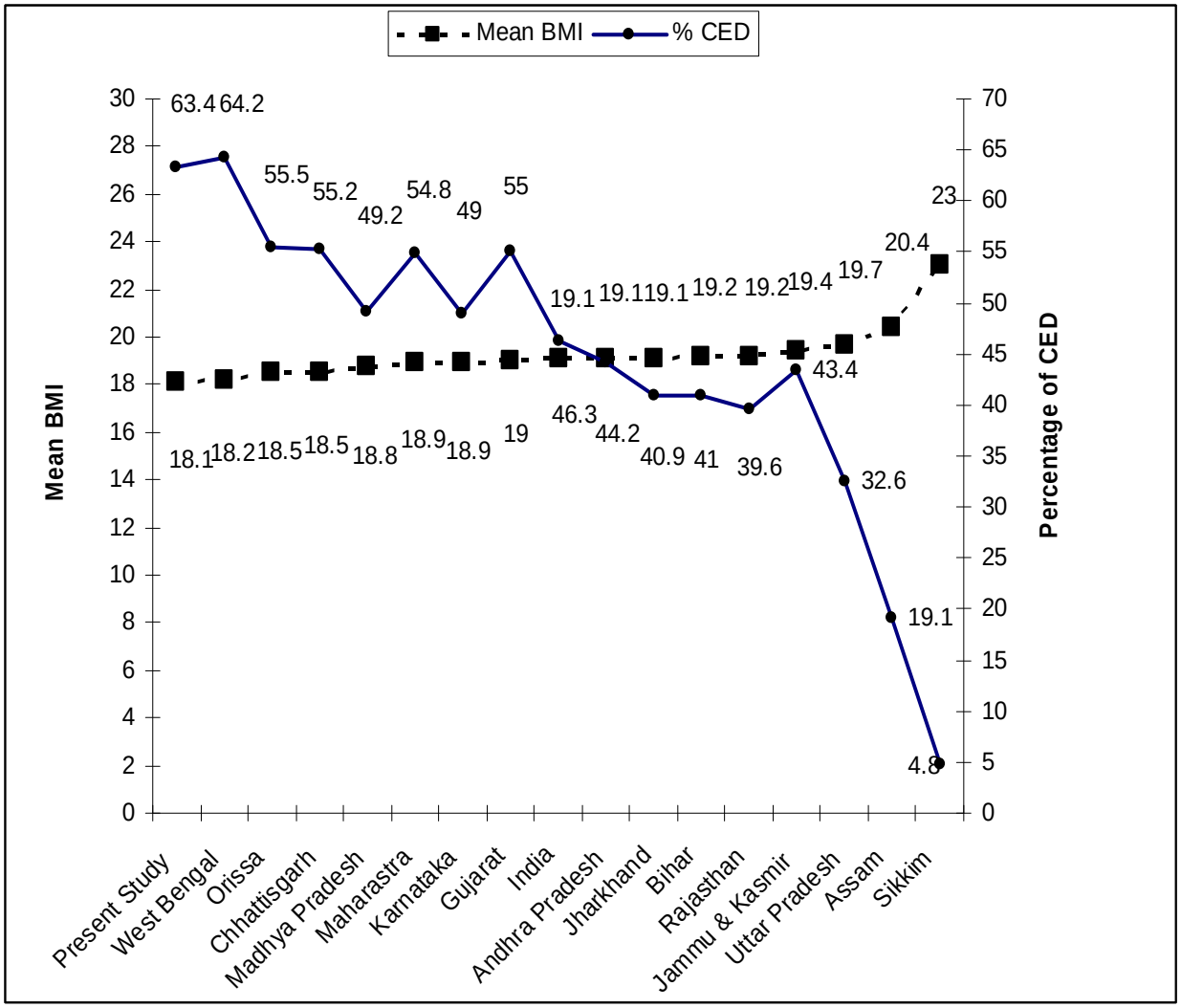
| Tribe | n | Mean BMI | CED (%) | Nutritional Condition | Study Area | Reference |
|---|---|---|---|---|---|---|
| Bhumij | 185 | 18.4 (2.9) | 58.9* [17.8] | Critical | Paschim Medinipur | Ghosh, (2007) |
| Dhimal | 146 | 19.1 (2.6) | 46.4* [8.2] | Critical | Darjeeling | Datta Banik et al. (2007) |
| 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 | Mondal (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] | Critical | Jalpaiguri | Mittal & Srivastava (2006) |
| Santal | 213 | 19.3 ^ (2.6) | 41.8* | Serious | Paschim Medinipur | Bose et al. (2006c) |
| Santal | 400 | 18.7** | 52.5 | Critical | Bankura | Ghosh & Mallik (2007) |
| **Santal** | **317** | **18.1 (2.2)** | **63.4*** ** | **Critical** | **Purulia** | **Present Study** |

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.
*** Significant sex difference of undernutrition; $p<0.001$.
() Presents standard deviation of the mean,
[] Presents percentage of CED grade III (BMI < 16.0).

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) have been undertaken in 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).

Das, S., Bose, K. (2010). Body Mass Index and Chronic Energy Deficiency among Adult Santals of Purulia District, West Bengal, India. *International Journal of Human Sciences* [Online]. 7:2. Available: http://www.insanbilimleri.com/en

**Figure 1: Mean BMI and prevalence of CED (based on BMI) among tribal females in various states of India.**




The primary importance, from the public health perspective is the need for immediate nutritional intervention programs to be implemented among Santals of Purulia and all other tribal groups experiencing nutritional stress. 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, our study as well as those cited by us, provided strong evidence that, in general, Santals and other 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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Das, S., Bose, K. (2010). Body Mass Index and Chronic Energy Deficiency among Adult Santals of Purulia District, West Bengal, India. *International Journal of Human Sciences* [Online]. 7:2. Available: http://www.insanbilimleri.com/en

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