

Relationship of Income with Anthropometric Indicators of Chronic Energy Deficiency among Adult Female Slum Dwellers of Midnapore Town

Kaushik Bose, Samiran Bisai, Priyanka Das, Swapan Dikshit and Sampa Pradhan

*Department of Anthropology, Vidyasagar University,
Midnapore, West Bengal, India*

KEYWORDS India.Midnapore. Income. Chronic Energy Deficiency. Body Mass Index

ABSTRACT A cross-sectional study of 333 adult (> 18 years) female slum dwellers (mean age = 34.2 years) of Midnapore town, West Bengal, India, was undertaken to study the relationships of monthly per capita income (MPCI) with two anthropometric measures, namely body mass index (BMI) and mid-upper arm circumference (MUAC). It also investigated the association of MPCI with chronic energy deficiency (CED). Results revealed that the mean height, weight, MUAC and BMI of the subjects were 148.2 cm, 43.2 kg, 22.7 cm and 19.6 kg/m², respectively. The overall frequency of CED based on BMI (BMI < 18.5 kg/m²) and MUAC (MUAC < 22.0 cm) was 46.8 % and 43.5%, respectively. Based on the World Health Organization classification, the prevalence of CED among this population was very high (≥40%) and thus the situation is critical. Overall, MPCI was significantly ($p < 0.001$) positively correlated with BMI ($r = 0.21$) and MUAC ($r = 0.25$). Moreover, MUAC was very strongly correlated ($r = 0.81$; $p < 0.0001$) with BMI. Linear regression analyses showed that MPCI had significant impact ($p < 0.001$) on BMI ($T = 3.92$) and MUAC ($T = 4.74$). MPCI explained 4.1% and 6.1% variation in BMI and MUAC, respectively. Subjects belonging to the lowest per capita income group (PCIG) had the lowest mean BMI (18.9 kg/m²) and mean MUAC (21.9 cm) and the highest rate of CED (BMI based CED = 52.3%; MUAC based CED = 53.5%). Those in the highest PCIG had the largest mean BMI (20.7 kg/m²) and MUAC (23.9 cm) and lowest rate of CED (BMI based CED = 39.0 %; MUAC based CED = 35.4 %). There were significant PCIG differences in mean BMI ($F = 4.115$, $p < 0.05$) and MUAC ($F = 6.995$, $p < 0.001$). Moreover, there existed clear PCIG differences in CED rates using both BMI as well as MUAC. In conclusion, this study provided evidence that PCI was significantly associated with BMI, MUAC and the presence of CED. The relationships of PCI with BMI and MUAC were similar. The rate of CED was very high indicating a critical situation. These findings may have severe public health implications. It is recommended that immediate appropriate nutritional intervention programmes be initiated among this population along with serious efforts to increase their PCI. In this population, either BMI or MUAC can be effectively used to study the effect of PCI on nutritional status.

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). Nevertheless, infant mortality rates dropped from 115 in 1980 to 70 in 1998, and the total fertility rate dropped from 5 to 3.2 during the same period (World Bank, 2000). Improvements in the nutritional status of the population have been less impressive (Griffiths and Bentley, 2001). More than half the world's undernourished population live in India (Krishnaswami, 2000).

The use of anthropometry as an indicator of nutritional and health status of adults has now

been well established (World Health Organization, 1995). The body mass index (BMI) is an indicator of overall adiposity and low BMI and high levels of undernutrition (based on BMI) is a major public health problem especially among rural underprivileged adults of developing countries (World Health Organization, 1995). Although adult nutritional status can be evaluated in many ways, the BMI is most widely used because its use is inexpensive, non-invasive and suitable for large-scale surveys (Lohman et al., 1988; Ferro-Luzzi et al., 1992; James et al., 1994). 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; Khongsdi, 2002). A BMI < 18.5 kg/m² is widely

Address for Correspondence: Dr. Kaushik Bose,
Reader and Head of Department, Department of
Anthropology, Vidyasagar University, Midnapore-
721 102, West Bengal, India
E-mail: banda@vsnl.net

used as a practical measure of chronic energy 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; World Health Organization, 1995).

Another anthropometric measure that can be used to evaluate adult nutritional status is mid-upper arm circumference (MUAC). It has been shown that MUAC is particularly effective in the determination of malnutrition among adults in developing countries (James et al., 1994). It has been noted that 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 (Breind et al, 1989). James et al. (1994) after an extensive study of 8 countries (Mali, India, Senegal, Zimbabwe, Somalia, Ethiopia, Papua New Guinea and China) suggested that MUAC could be used for simple screening of nutritional state.

It has also been stated that since MUAC is a simpler measure than BMI, it could be used not only in emergencies but also when semi-skilled monitors are available. It can be used as a substitute for BMI when rapid screening of an adult population is required as a prelude to targeting help for the undernourished (James et al., 1994).

Several recent investigations have studied the relationships of socio-economic status with BMI and CED among different populations (Delpuch et al., 1994; Ahmed et al., 1998; Reddy, 1998; Khongsdier, 2002; Pryer et al., 2003; Monteiro et al., 2004; Clausen et al., 2006; Mahmud et al., 2006). However, we could not locate any study from West Bengal, India, that has dealt with the nature and extent of relationship of monthly per capita income (MPCI) with BMI, MUAC and CED among urban females. In view of this, the present investigation was undertaken to study the relationship of MPCI with BMI, MUAC and CED among adult female urban slum dwellers of Midnapore town, West Bengal, India.

MATERIALS AND METHODS

This study was carried out as part of an ongoing research project being undertaken by the authors. The study area comprised of a slum named 'Mazdoor Nagar', situated in Ward number

13 of Midnapore town. Midnapore town is approximately 130 kms from Kolkata, the provincial capital of West Bengal. The vast majority of the subjects belonged to low socio-economic status. All adult (> 18 years) females of the area were requested to participate in the study and the response rate was approximately 78%.

Ethical approval and prior permission was obtained from Vidyasagar University Ethics Committee and local community leaders, respectively, before commencement of the study. Informed consent was also obtained from each participant. Information on age and MPCI were obtained from all subjects with the help of a questionnaire. MPCI was recorded in Rupees (Rs.). The current exchange rate is 1 US\$ = 45 Rs. (approximate). MPCI was further divided into the following four per capita income groups (PCIG) based on quartile values of MPCI. The corresponding cut-off values for PCIG I, PCIG II, PCIG III and PCIG IV were (<333.33), (33.33-560.0), (560.0-866.67) and (>866.67), respectively.

All anthropometric measurements were made by trained investigators (PD, SD and SP) following the standard techniques (Lohman et al., 1988). Height, weight and mid upper arm circumference (MUAC) were recorded to the nearest 0.1 cm, 0.5 kg and 0.1 cm, respectively. Technical errors of measurements (TEM) were computed and they were found to be within acceptable limits (Ulijaszek and Kerr, 1999). BMI was computed using the following standard equation:

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

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

- CED Grade III: BMI < 16.0
- CED Grade II: BMI = 16.0 – 16.9
- CED Grade I: BMI < 17.0 – 18.4
- Normal: BMI = 18.5 – 24.9
- Overweight: BMI ≥ 25.0.

The World Health Organization's classification (World Health Organization, 1995) of the public health problem of low BMI, based on adult populations worldwide, was followed. 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.

Nutritional status was also evaluated following the internationally accepted standard sex specific cut-off point (James et al., 1994). The following was used:

Undernutrition: MUAC < 22.0 cm
Normal: MUAC $\geq$ 22.0 cm.

The distributions of the anthropometric variables were not significantly skewed. Pearson correlation coefficient (*r*) and linear regression analyses was used to study the interrelationships of MPCII, BMI and MUAC. Oneway analyses - Scheffe's procedure (Mascie-Taylor, 1994a, 1994b) were used to test for differences in mean BMI and MUAC between the four PCIG. All statistical analyses were undertaken using the SPSS 7.5 Statistical Package. Statistical significance was set at $p < 0.05$.

RESULTS

The characteristics of the study sample are presented in Table 1. The mean age of the subjects was 34.2 years (*sd* = 14.0 years). Mean MPCII was Rs. 693.2 (*sd* = 527.5). Mean height, weight, MUAC and BMI of the subjects were 148.2 cm (*sd* = 6.4 cm), 43.2 kg, (*sd* = 8.8 kg), 22.7 (3.2) and 19.6 kg/m² (*sd* = 3.6 kg/m²), respectively.

Table 2 presents the nutritional status (based on BMI) of the subjects. The prevalence of CED was 46.8 %. Of these, 13.8 %, 11.7 % and 21.3 % belonged to CED III, CED II and CED I categories, respectively. Only 6.6 % belonged to the overweight category. Based on the WHO (1995) classification, the prevalence of CED among this population was very high (46.8 %) and thus the situation is critical. Similar findings were obtained (Fig. 1) when MUAC was used to evaluate nutritional status. It was observed that 43.5 % of individuals belonged to undernutrition category.

Table 3 presents the relationships of MPCII with mean BMI, MUAC and CED prevalence among the subjects. Results showed that PCIG I

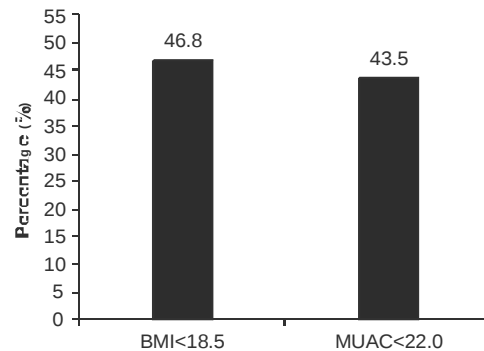


Fig. 1. Prevalence of undernutrition based on BMI and MUAC.

Table 1: Characteristics of the study sample.

Variable	Mean	sd
Age (years)	34.2	14.0
Monthly per capita income (Rs.)	693.2	527.5
Height (cm)	148.2	6.4
Weight (kg)	43.2	8.8
MUAC (cm)	22.7	3.2
BMI (kg/m ²)	19.6	3.6

Table 2: Nutritional status of the subjects based on BMI.

Category	Percent
CED III	13.8
CED II	11.7
CED I	21.3
Normal	45.3
Overweight	6.6
Obese	1.2

Total CED = 46.8%.

had the lowest mean BMI (18.9 kg/m²) and MUAC (21.9 cm) while PCIG IV had the highest mean BMI (20.7 kg/m²) and MUAC (23.9 cm). There were significant PCIG differences in mean BMI ($F = 4.115$, $p < 0.05$) and mean MUAC ($F = 6.995$, $p < 0.001$). Moreover, the rate of CED was highest (BMI based = 52.3 %; MUAC based = 53.5 %) in the lowest PCIG. There was a decreasing

Table 3: Relationships of PCIG with mean BMI, MUAC and CED prevalence.

PCIG	n	Mean BMI*	% CED	Mean MUAC	%CED
I	86	18.9 (3.3)	52.3	21.9 (2.7)	53.5
II	81	19.2 (3.4)	48.2	22.2 (2.8)	43.2
III	84	19.6 (3.3)	47.6	22.7 (2.9)	41.7
IV	82	20.7 (4.3)	39.0	23.9 (3.9)	35.4

PCIG = Per capita income group.

Standard deviations are presented in parentheses.

* Significant PCIG difference in mean BMI; $F = 4.115$, $p < 0.05$.

Significant PCIG difference in mean MUAC; $F = 6.995$, $p < 0.001$.

trend in CED prevalence with increasing PCIG with PCIG IV having the lowest rate (BMI based = 39.0 %, MUAC based = 35.4 %).

The results of Pearson correlation analyses (Table 4) showed that MPCl were significantly positively correlated ($p < 0.01$) with BMI ($r = 0.21$) and MUAC ($r = 0.25$). Moreover, MUAC was very strongly correlated ($r = 0.81$; $p < 0.01$) with BMI. The results of linear regression analyses of MPCl with BMI and MUAC are presented in Table 5. Regression analyses demonstrated that MPCl had significant ($p < 0.001$) impact on BMI ($T = 3.92$) and MUAC ($T = 4.74$). The percent variation in BMI and MUAC explained by MFI were 4.1 % and 6.1 %, respectively.

Table 4: Pearson correlation coefficient between MPCl, BMI and MUAC.

Variables	MPCl	BMI	MUAC
MPCl	1.000	0.211**	0.252**
BMI		1.000	0.808**
MUAC			1.000

** Correlation is significant at the 0.01 level.

DISCUSSION

It is only recently that there has been an attempt to assess malnutrition in adults living in the Third World. This seems surprising given the widespread concern about world hunger and whether food supplies are adequate for populations of different regions of a country or for those living in refugee camps (James et al., 1994). Several recent studies worldwide have clearly established that low socio-economic status is associated with low mean BMI and high rates of CED among adults (Shetty and James, 1994; Ene-Obong et al., 2001; Pryer et al., 2003; Clausen et al., 2006; Pryer and Rogers, 2006) in different populations. However, although a large section of the Indian population live in poverty (World Bank, 2000), extensive efforts have not been made to study the nature and extent association of MPCl with BMI, MUAC and CED

among them. The present study attempted to study this association among slum-dwelling adult women of Midnapore town. To the best of our knowledge, this is the first report dealing with the nature and extent of association of MPCl with BMI, MUAC and CED among adult women of Midnapore, India.

Results clearly demonstrated that MPCl was significantly positively associated with BMI as well as MUAC. It was also observed that MPCl was significantly negatively associated with CED prevalence rate. It is interesting to note that this significant negative association was similar using both methods of evaluating undernutrition, i.e., BMI as well as MUAC. Moreover, MUAC was very strongly correlated ($r = 0.81$; $p < 0.01$) with BMI which was similar to the findings of James et al. (1994) from their study conducted in eight countries including India. Thus, in this population, either BMI or MUAC can be effectively used to study the effect of MPCl on nutritional status. This is in concordance with the suggestions made by James et al. (1994).

More importantly, the prevalence of CED was very high and thus the situation is critical. Similar high rates of CED have also been reported in recent studies among other populations who are economically disadvantaged like Bathudis in Keonjhar, Orissa (Bose and Chakraborty, 2005) and Kora Mudis of Bankura (Bose et al., 2006). These high rates are clearly indicative of a strong association between low economic condition and high prevalence of CED.

The public health implications of these findings are very important since low BMI/MUAC and high CED are likely to be associated with morbidity or other physiological and functional impairments (James et al., 1988; Shetty and James, 1994; World Health Organization, 1995). Therefore, the following two important recommendations for implementation, with respect to primary health care and health promotion among this population, can be made based on the results of this study:

- 1) Immediate appropriate nutritional inter-vention be initiated
- 2) Concrete steps be taken to increase the MPCl

Table 5: Linear regression analyses of BMI and MUAC with MPCl.

Dependent Variable	B	seB	Beta	Adj.R ²	T	p <
BMI	0.0014	0.000	0.211	0.041	3.92	0.001
MUAC	0.0015	0.000	0.252	0.061	4.74	0.001

MPCl was used as an independent variable.

through more or better educational and employment opportunities.

It is expected that both these measures would help in increasing mean BMI/MUAC and therefore reduce the rate of CED in this population. It should be noted here that while the first recommendation may generate immediate benefits, the overall long-term improvement, from the public health point of view, might lie with the second recommendation.

There is a paucity of data in India dealing with income and nutritional status. Thus, similar studies should be carried out among various ethnic groups in India. India is a land of vast ethnic heterogeneity. Such investigations would generate more information as to whether the relationships of MPCII with BMI/MUAC and CED observed in the present study are similar in different ethnic populations of India. It would then be possible to compare the results of the present study with other Indian studies. Lastly, there is urgent need for studies dealing with primary health care, income, BMI, MUAC and CED.

ACKNOWLEDGEMENTS

All subjects who participated in the study are gratefully acknowledged.

REFERENCES

- Ahmed, S.M., Adams, A., Chowdhury, A.M. and Bhuiya, A.: Chronic energy deficiency in women from rural Bangladesh: Some socioeconomic determinants. *J. Bio. Sci.*, **30**: 349-358 (1998).
- Bose, K. and Chakraborty, F.: Anthropometric characteristics and nutritional status based on body mass index of Bathudis: a tribal population of Keonjhar District, Orissa, India. *Asia Pac. J. Clin. Nutr.*, **14**: 80-82 (2005).
- Bose, K., Ganguly, S., Mamta, H., Mukhopadhyay, A. and Bhadra, M.: High prevalence of undernutrition among adult Kora Mudi tribals of Bankura District, West Bengal, India. *Anthropol. Sci.*, **114**: 65-68 (2006).
- Briend, F., Garenne, M., Maire, B., Fontaine, O. and Dieng, K.: Nutritional status, age and survival: the muscle mass hypothesis. *Eur. J. Clin. Nutr.*, **43**: 715-726 (1989).
- Clausen, T., Charlton, K.E. and Holmboe-Ottesen, G.: Nutritional status, tobacco use and alcohol consumption of older persons in Botswana. *J. Nutr. Health and Aging*, **10**: 104-110 (2006).
- Delpuech, F., Cornu, A., Massamba, J.P., Traissac, P. and Maire, B.: Is body mass index sensitivity related to socio-economic status and to economic adjustment? A case study from the Congo. *Eur. J. Clin. Nutr.*, **S3**: S141-S147 (1994).
- Ene-Obong, H.N., Enugu, G.I. and Uwaegbute, A.C.: Determinants of health and nutritional status of rural Nigerian women. *J. Health, Popu. Nutr.*, **19**: 320-330 (2001).
- Ferro-Luzzi, A., Sette, S., Franklin, M. and James, W.P.T.: A simplified approach of assessing adult chronic deficiency. *Eur. J. Clin. Nutr.*, **46**: 173-186 (1992).
- Griffiths, P.L. and Bentley, M.E.: The Nutrition Transition Is Underway in India. *J. Nutr.*, **131**: 2692-2700 (2001).
- James, W.P.T., Ferro-Luzzi, A. and Waterlow, J.C.: Definition of Chronic energy deficiency in adults. Report of a Working Party of the International Dietary Energy Consultative Group. *Eur. J. Clin. Nutr.*, **42**: 969-981 (1988).
- James, W.P.T., Mascie-Taylor, C.G.N., Norgan, N.G., Bristrian, B.R., Shetty, P. and Ferro-Luzzi, A.: The value of arm circumference measurements in assessing chronic energy deficiency in Third World adults. *Eur. J. Clin. Nutr.*, **48**: 883-894 (1994).
- Khongsdier, R.: Body mass index and morbidity in adult males of the War Khasi in Northeast India. *Eur. J. Clin. Nutr.*, **56**: 484-489 (2002).
- Khongsdier R.: BMI and morbidity in relation to body composition: a cross-sectional study of a rural community in North-East India. *Br. J. Nutr.*, **93**: 101-107 (2005).
- Krishnaswami, K.: Country profile: India. Nutritional disorders – old and changing. *Lancet*, **351**: 1268-1269 (2000).
- Lee, R.D. and Nieman, D.C.: *Nutritional Assessment*. McGraw Hill, New York (2003).
- Lohman, T.G., Roche, A.F. and Martorell, R.: *Anthropometric Standardization Reference Manual*. Human Kinetics Books, Chicago (1988).
- Mascie-Taylor, C.G.N. (1994a). Analysing cross-sectional anthropometric data. *Eur. J. Clin. Nutr.*, **48**: S190-S202 (1988).
- Mascie-Taylor, C.G.N.: Statistical issues in anthropometry. pp 56-77. In: *Anthropometry: The Individual and the Population*. S. J. Uljaszek and C. G. N. Mascie-Taylor (Eds.). Cambridge University Press, Cambridge (1994b).
- Mahmud-Khan, M., Hotchkiss, D.R., Berruti, A.A., and Hutchinson, P.L.: Geographic aspects of poverty and health in Tanzania: does living in a poor area matter? *Health. Pol. and Plan.* **21**: 110-122 (2006).
- Monteiro, C.A., Conde, W.L., and Popkin, B.M. The burden of undernutrition and overnutrition in countries undergoing rapid nutrition transition: a view from Brazil. *Am. J. Pub. Health*, **94**: 433-434 (2004).
- Nube, M., Asenso-Okyere, W.K. and Van Den Bloom G.J.M.: Body mass index as an indicator of standard of living in developing countries. *Eur. J. Clin. Nutr.*, **77**: 1186-1191 (1998).
- Pryer, J.A., and Rogers, S.: Epidemiology of undernutrition in adults in Dhaka slum households, Bangladesh. *Eur. J. Clin. Nutr.*, **62**: 1-8.
- Pryer, J.A., Rogers, A., and Rahman, A.: Factors affecting nutritional status in female adults in Dhaka slums, Bangladesh. *Soc. Biol.*, **50**: 259-269 (2003).
- Reddy, B.N.: Body mass index and its association with socioeconomic and behavioral variables among socioeconomically heterogeneous populations of Andhra Pradesh, India. *Hum. Biol.*, **70**: 901-917 (1998).

- Shetty, P.S. and James, W.P.T.: Body Mass Index: A measure of Chronic Energy Deficiency in Adults. *Food and Nutrition Paper No. 56*. Food and Agricultural Organization, Rome. (1994)
- Ulijaszek, S.J. and Kerr, D.A.: Anthropometric measurement error and the assessment of nutritional status. *Br. J. Nutr.*, **82**: 165-177 (1999).
- World Bank: *World Development Report 2000/2001: Attacking Poverty*. Oxford University Press, New York (2000).
- World Health Organization. *Physical Status: the Use and Interpretation of Anthropometry*. Technical Report Series no. 854.: World Health Organization, Geneva (1995).