Coll. Antropol. **41** (2017) 4: 327–334
Original scientific paper

Understanding Chronic Energy Deficiency among Population Living Under Limited Nutritional Resources

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A B S T R A C T

The present study examines the prevalence of chronic energy deficiency (CED), with a specific emphasis on the role of socio-economic factors, amongst the Santhals, a tribal community of East-Central India. A cross-sectional study was conducted on 1262 adults among the Santhals of Bankura District, West Bengal, India. An assessment of nutritional status revealed a high prevalence (46.9%) of undernutrition among Santhal adults. Santhal males were found to be at lower risk of CED relative to females and this difference was statistically significant (dy/dx = -0.410, p = 0.008). Lower economic status and morbidity profile play crucial contributing roles to the prevalence of underweight among this forest dwelling population. However, being underweight among Santhal adults does not result in greater risk for poor public health. Hence, from an adaptive perspective it is important, at least among this tribal population, that thin adults be distinguished from at-risk underweight adults.

***Key words:** chronic energy deficiency, developmental plasticity, steady state balance, forest dwelling indigenous community, average marginal effects*

Introduction

Chronic energy deficiency (CED) is defined as a »steady state« where an individual is in energy balance. More specifically in such state energy intake is equivalent to energy expenditure.[1] Needless to mention that maintenance of such »state« will always require subnormal nutritional consumption. Such scenario is generally observed among marginalized forest dwelling indigenous populations with limited nutritional resources and/or access. Indigenous populations from India are no exception to this.[2,3,4] Among adults CED does not result in prolonged and continuous loss of body weight and energy.[5] The underlying principle here is that human beings have enormous »plasticity« and are able to adapt to any environmental conditions.[6] In line with this concept, Barker[7] has developed the »Fetal origin« or »Thrifty phenotype« hypothesis. Human fetus is able to adapt to a limited supply of nutrients by changing its physiological and metabolic mechanisms. In response to maternal undernutrition, the fetus may change by either reducing its size to meet the nutrient requirements or altering the production of hormones that regulate growth.[7]

With significantly high percentages of forest dwelling indigenous populations, India is typically known for a high prevalence of undernutrition and protein-calorie malnutrition.[8,9] According to the National Institute of Nutrition,[10] about 40% of adult men and 49% of adult women in tribal communities have a BMI below 18.5, which indicates chronic energy deficiency. National Nutrition Monitoring Bureau (NNMB) data further suggests that adult members of India's tribal populations are more undernourished than their rural non-tribal counterparts.[11] Further, it has been reported that human labor provides bulk of the inputs to economic production in India.[12] This is very common in the rural areas, especially amongst the indigenous populations. Consequently, requirement of strenuous and laborious physical activities to sustain their daily livelihood affects their body composition and nutritional status.[13] This scenario is particularly more present in West Bengal than in other states of India, as West Bengal has the highest rate of CED among adult members of indigenous populations.[14] For this reason, present paper focuses

Received for publication November 28, 2017

on a forest dwelling indigenous community from West Bengal, India.

In this connection, previous investigators have suggested the following from their BMI-based data. Inadequate dietary intake and poor socio-economic conditions are the influential factors contributing to the high prevalence of CED among adult members of indigenous populations, like Dhimal[15], Kora Mudi[3], Munda[16], Oraon[4], and Santal[2]. However, these assumptions do not address a number of important points. For example, these forest dwelling indigenous communities are living in their present habitat for hundreds of generations under the same environmental and socio-economic conditions, yet they successfully maintain their nutritional status for generations at »steady state« (CED) level without deteriorating to a state of negative energy balance or acute energy deficiency (AED). If poor socio-economic condition were the only determining factor behind such state then it would be highly unlikely for them to able to preserve their nutritional status at the »steady state« level without further deterioration. Hence, perhaps maintaining »steady state« level has an adaptive advantage for these communities. It may be worth mentioning here that ancestors of all these indigenous communities were hunter-gatherers, who successfully adapted for centuries under limited nutritional resources.

Thus, the present paper aims to understand whether »steady state« level of nutritional status can be advantageous for one such forest dwelling indigenous community (Santhals), who have been residing in southern and western part of West Bengal for at least five hundred years.[17] The paper further investigates the prevalence of chronic energy deficiency and its determinants among Santhals with a special emphasis on their morbidity history.

Materials and methods

Data sources and sampling techniques

A cross-sectional study was conducted on 1262 adult Santhals from 18 villages located within Ranibandh Block of Bankura District, West Bengal, India. The selection of the Ranibandh Block and the specific villages within this block was based upon multi-stage random cluster sampling. Random sampling was used in each of the 18 villages to select the subjects included in the study. The Santhals are the largest tribe in India to retain an aboriginal language (Santali) to the present day, belonging to the Austro-Asiatic family. They are sedentary agriculturists. Their habitational villages are mostly located on hilly terrain covered with forest. The plain in the local vicinity is characterized by lateritic reddish soil that has a low water retention capacity, which makes cultivation (the primary occupation among a majority of Santhals) a high-energy, back-breaking physical endeavor. Further, the agricultural practice of the Santhals reveals that they do not produce enough food items that are rich in protein, for instance, they do not produce pulses at all.[18] As a consequence, sources of nutrition are limited for Santhals in their subsistence economy.

The sample included 692 males, between 18 and 87 years of age (mean 44.4 years) and 570 females, between 18 and 83 years of age (mean 41.5 years). All the measurements and other information were collected by the author after obtaining informed consent from the voluntary participants encompassed by the study. Ethical clearance was obtained from the Department of Anthropology, University of Delhi, India for conducting this research work.

Socio-economic data

Socio-economic data were collected by interviewing the subjects. Nutritional data, such as daily protein intake, was collected through 24 hour recall methods.[11] Perhaps, it is worth mentioning here that Santhals are non-vegetarian and they relish consuming fish, chicken and beef. However, they cannot afford to consume non-vegetarian food and/or pulses on regular basis. Thus, their daily meal is generally consisting of boiled rice and green vegetables.

Standard of living index

The standard of living index of the household for each subject was calculated by using a set of proxy indicators. These include: (i) house type; (ii) availability of water on the premises; (iii) toilet facility in the household; (iv) availability of electricity in the household; (v) type of fuel for cooking; (vi) availability of separate kitchen in the household; and (vii) possession of consumer durables (such as a scooter, motorcycle, bicycle, radio, TV etc.). Each item was assigned an ordinal score along a five-point scale ranging from 0 to 4.[19,20] When considered together, the standard of living index for the household to which a specific Santhal subject belongs can range from a low 0 to a high of 28.[19,20]

Self-reported morbidity

A structured survey was used to collect self-reported morbidity; that is, information about the types and occurrences of illnesses reported by the subjects for the last twelve months prior to the date of the survey.[21]

Anthropometric measurements

Anthropometric measurements were taken following the standards set forth by Weiner and Lourie.[22] A weighing scale and anthropometer were used for the measurements of weight (kg) and height (m), respectively. Mid-upper arm circumference was measured with the help of a tailor meter. Skinfold measurements were taken with a Holtain skinfold caliper in mm, with the dial marked with divisions of 0.2 mm. Subjects with any physical deformity, as well as lactating and/or pregnant women were excluded from the sample.

Body mass index (BMI)

BMI formula is given by,

Weight (kg)/height (m^2)

The subjects were classified into the various levels of CED in accordance with the BMI classification set forth by the World Health Organization for Asian populations[23]: CED Grade III (Severe) < 16.00 kg/m^2; CED Grade II (Moderate) 16.00 – 16.99 kg/m^2; CED Grade I (Mild) 17.00 – 18.49 kg/m^2; Normal weight 18.50 – 22.99 kg/m^2; and Overweight ≥ 23.00 kg/m^2.

Statistical analysis

All statistical computations were accomplished with SPSS 15.0 and STATA 11.1 for Windows. Anthropometric differences between individuals classified as suffering from CED and those unaffected by CED were compared with one-way analysis of variance (ANOVA). In addition, to estimate the prevalence of CED, contingency χ^2 test has been used to understand the association between the prevalence of CED and self-reported morbidity as well as between CED and age groups.

Logistic regression model

In the current study CED is considered a dependent variable whose status is both categorical and binary, being either present (1) or absent (0). Logistic regression is used to assess the effect of an array of various factors that have been identified by other researchers as potential contributors to the occurrence or non-occurrence of CED. Logistic regression models are non-linear. Consequently, the partial derivative, or the marginal effect, of an independent variable and the β coefficients are not the same in logistic models as they are in linear regression*. This paper reports the average marginal effects (AME). That is, a marginal effect has been computed for each case and then averaged across all cases considered[24]. As such, AMEs indicate how changes in the independent variable (X_k) affect the various dependent variable $P(Y_{CED=1})$ on average. For categorical variables, the effects of discrete changes have been computed, i.e., the marginal effects for categorical variables showed the effect on $P(Y_{CED=1})$ when an independent variable (X_k) is changed from 0 to 1 holding all the other independent variables (Xs) equal. The marginal effects for the independent variable, say x, has been denoted by »dy/dx«.

Categorical or nominal variables, such as gender, level of education, economic status, family pattern, smoking habit, drinking habit and self-reported morbidity (SRM), have been incorporated into the regression model by means of dummy variables, 'Z', 'E', 'D', 'F', 'Q', 'B' and 'S', respectively.

Where,

$$Z = \begin{cases} 1 & \text{if Male} \\ 0 & \text{if Female} \end{cases}$$

$$E = \begin{cases} 1 & \text{if Illiterate} \\ 0 & \text{if Literate} \end{cases}$$

Here, Santhals who can neither read nor write or have never gone to school are considered »Illiterate«. On the other hand, the Santhals who can read and write or who have gone or are currently going to school/college are considered »Literate«.

$$D = \begin{cases} 1 & \text{if Low Economic Group} \\ 0 & \text{if High Economic Group} \end{cases}$$

Here, the Santhals belonging to the primary occupational categories »Labourer« and »Owner cultivator/labourer« are assigned to the »Low Economic Group« (LEG), while Santhals belonging to the primary occupational categories »Owner cultivator«, »Government employee« and »Businessman« are assigned to the »High Economic Group«(HEG).

$$F = \begin{cases} 1 & \text{if Joint} \\ 0 & \text{if Nuclear} \end{cases}$$

Here, a Santhal belonging to a joint or extended family is given the value '1', while those belonging to a nuclear family are given the value '0'.

$$Q = \begin{cases} 1 & \text{if Smoker} \\ 0 & \text{if Non smoker} \end{cases}$$

Here, a Santhal who is a smoker is assigned a value of '1', while Santhal who has never smoked is assigned a value '0', irrespective of gender.

$$B = \begin{cases} 1 & \text{if drink alcohol} \\ 0 & \text{if never drink alcohol} \end{cases}$$

Here, a Santhal who consumes alcohol is given the value '1' and a Santhal who has never consumed alcohol is given the value '0', irrespective of gender.

and

$$S = \begin{cases} 1 & \text{if reported morbidity} \\ 0 & \text{if not reported morbidity} \end{cases}$$

Here, a Santhal who has reported any illness during the year prior to the survey is given the value '1', while a Santhal who has not reported any illness during the year prior to the survey is given the value '0'.

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* Let y be a binary dependent variable. Let $x_1,\ldots, x_k$ be the explanatory variables. Define, z= $\beta_0 + \beta_1 x_1 + \ldots + \beta_k x_k$, and let G(.) be a function of z. In a binary regression model we are interested in the conditional probability $P(y=1| x_1,\ldots, x_k)$, where $P(y=1| x_1,\ldots, x_k)=G(z)$. Note that, if G(.) is a linear function then we obtain the linear probability model because in that case G(z)=z== $\beta_0 + \beta_1 x_1 + \ldots + \beta_k x_k$. In case of a logit model G(.) follows logistic distribution.

Hence, for a logit model $P(y=1|x)=G(z)=G(\beta_0 + \beta_1 x_1 + \ldots + \beta_k x_k)= \dfrac{\exp(\beta_0 + \beta_1 x_1 + \cdots + \beta_k x_k)}{1+\exp(\beta_0 + \beta_1 x_1 + \cdots + \beta_k x_k)}$

Note now that G(.) is a non-linear function of z. Hence β is do not tell us the marginal effect of x_is, that is effect of a unit change in x_i on the probability of y=1. That is, the partial derivative of the function G(.) with respect to x_i is not β_i, for a logistic model. In other words, marginal effect of the variable x_i is a function of x_i instead of the constant β_i, for a logistic model. The average marginal effect reported in the paper is average taken over the sample, after estimating the coefficients. For more details, see the STATA manual.

TABLE 1
DESCRIPTIVE STATISTICS OF ANTHROPOMETRIC CHARACTERISTICS AMONGST ADULT SANTHALS OF WEST BENGAL, BY AGE

Anthropometric Measurements	Age Groups													
	18-20 (N=65)		21-30 (N=162)		31-40 (N=55)		41-50 (N=95)		51-60 (N=188)		61 and Older (N=127)		All Males (N=692)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Males														
Height (m)	1.62	0.06	1.63	0.06	1.63	0.07	1.61	0.05	1.60	0.06	1.58	0.07	1.61	0.06
Body Weight (kg)	49.85	5.04	52.25	6.32	53.47	6.46	48.79	6.52	47.88	7.00	45.20	6.26	49.17	6.94
Mid upper arm circumference (m)	0.24	0.02	0.25	0.02	0.26	0.02	0.25	0.02	0.24	0.02	0.23	0.02	0.24	0.02
Body Mass Index (kg/m2)	18.94	1.64	19.61	2.04	20.02	2.06	18.85	2.39	18.64	2.21	18.06	2.36	18.93	2.36
Skinfold at Biceps (mm)	4.03	1.08	4.01	1.55	4.19	1.76	3.78	1.20	3.89	1.62	3.52	1.22	3.87	1.46
Skinfold at Triceps (mm)	5.36	1.82	5.78	2.47	5.93	3.01	5.37	2.10	5.58	2.45	5.42	2.06	5.58	2.34
Skinfold at Subscapula (mm)	8.25	2.04	9.76	3.64	10.48	4.33	9.51	3.52	9.55	4.83	8.37	3.83	9.33	4.01
Skinfold at Suprailliac (mm)	4.98	1.80	6.01	2.60	6.40	3.65	5.74	2.27	6.01	3.04	5.87	2.46	5.88	2.71
Log Sum of Skinfolds	1.34	0.10	1.39	0.13	1.40	0.15	1.37	0.13	1.37	0.16	1.34	0.15	1.37	0.14
Females														
	18-20 (N=59)		21-30 (N=86)		31-40 (N=85)		41-50 (N=202)		51-60 (N=99)		61 and Older (N=39)		All Females (N=570)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Height (m)	1.51	0.06	1.51	0.06	1.49	0.05	1.50	0.06	1.49	0.06	1.47	0.06	1.49	0.06
Body Weight (kg)	42.85	5.37	42.38	6.09	41.30	6.33	42.94	6.95	40.28	6.00	38.23	5.40	41.82	6.44
Mid upper arm circumference (m)	0.24	0.02	0.23	0.02	0.23	0.02	0.24	0.02	0.23	0.02	0.22	0.03	0.23	0.02
Body Mass Index (kg/m^2)	18.88	2.22	18.65	2.66	18.55	2.67	19.18	2.90	18.27	2.69	17.69	2.43	18.72	2.72
Skinfold at Biceps (mm)	6.47	2.47	5.05	2.18	4.59	3.15	5.05	2.60	4.65	2.16	3.71	1.52	4.97	2.55
Skinfold at Triceps (mm)	9.88	3.55	8.06	3.11	7.67	3.59	9.18	4.51	8.53	3.98	6.93	3.10	6.93	3.10
Skinfold at Subscapula (mm)	12.57	4.18	10.73	3.77	10.51	4.47	12.59	5.95	11.75	5.14	9.60	5.03	11.65	5.16
Skinfold at Suprailliac (mm)	9.77	4.61	8.73	4.66	7.68	4.11	9.87	5.47	8.65	4.78	6.41	3.60	8.91	4.93
Log Sum of Skinfolds	1.57	0.14	1.49	0.14	1.45	0.16	1.52	0.18	1.49	0.17	1.39	0.18	1.50	0.17

Results

Anthropometric characteristics of adult Santhals indicate a marginal decrease in anthropometric measures and body mass index in elderly adults, especially after 50 years of age (Table 1). BMI based nutritional status of Santhals indicates a high prevalence (46.9%) of undernutrition (BMI < 18.50 kg/m^2) in this population[18] in which the prevalence of CED is significantly higher among females (50.0%) than among males (44.4%) ($\chi^2 = 13.687$; $p = 0.008$). An examination of nutritional status by age group reveals that the prevalence of severe chronic energy deficiency (CED III) increases gradually with advancing age[18]. Contingency chi-square analysis reveals that differences in the nutritional status across age groups are highly significant ($\chi^2 = 65.378$; $p = 0.000$).

The prevalence of chronic energy deficiency according to morbidity pattern (self- reported morbidity) is shown in Figure 1. Majority of the participants who reported illnesses were reported »Malaria« as the major type of illness, followed by »Tuberculosis« and »Typhoid«. Although the prevalence of chronic energy deficiency is greater among individuals who reported illness than among those who did not report any illness, but the differences are not statistically significant ($\chi^2 = 5.994$; $p = 0.200$).

Table 2 provides average and standard deviations for anthropometric measurements among Santhal individuals classified as CED and non-CED[25]. Not surprisingly, the results indicate that all of the fat- and mass-related, variables (weight, mid-upper arm circumference, body mass, sum of skinfolds) are significantly greater among Santhals not affected by chronic energy deficiency than among those affected by the condition.

The results from logistic regression are presented in Table 3. The significance of the effects of the independent variables is tested at the 5% probability level. The specification of the logit model in this paper includes age^2, which measures the effect on CED status due to change in age »as age changes«. Positive and statistically significant marginal effect of age^2 on CED indicates that with the increase in age, the effect of age on the likelihood of an individual suffering from CED increases. As such, among the Santhal individuals considered here, members of the younger age groups tend to be unaffected by CED, whereas members of the older age groups are more likely to be affected by CED.

Overall, Santhal females have 9.4% higher probability of developing CED relative to males (dy/dx = -0.094, $p < 0.01$), which is statistically significant. Economic status, as captured in the present study by primary occupation, has a profound and statistically significant impact on the prevalence of CED, for those Santhals assigned to the Low Economic Group (LEG) have 17.2% greater probability of developing CED than those assigned the High Economic Group (HEG) (dy/dx

TABLE 2
ANTHROPOMETRIC VARIABLES ACCORDING TO CHRONIC ENERGY DEFICIENCY (CED) AMONG THE ADULT SANTHALS OF WEST BENGAL

Anthropometric Measurements	Reported CED (BMI < 18.5 kg./m²) N=592		Non CED (BMI ≥ 18.5 kg./m²) N=670		F – Statistics
	Mean	SD	Mean	SD	
Height (m)	1.56	0.08	1.55	0.09	1.596
Body Weight (kg)	41.17	5.63	49.98	6.77	622.317*
Mid upper arm circumference (m)	0.23	0.02	0.25	0.02	361.104*
Body Mass Index (kg/m2)	16.82	1.35	20.61	1.93	1584.380*
Sum of Skinfolds§ (mm)	23.77	9.58	33.50	14.16	198.991*
Log Sum of Skinfolds	1.35	0.14	1.49	0.17	255.715*

§Sum of skinfold = skinfold thickness at (biceps+triceps+subscapular+suprailiac)

* $P < 0.001$

TABLE 3
LOGIT MODEL: AVERAGE MARGINAL EFFECTS (AME) OF SOCIO-ECONOMIC FACTORS ON CED AMONG THE ADULT SANTHALS OF WEST BENGAL

Predictor Variables	ß	dy/dx	Delta-method standard error§	z	P > | z |*
Age	-0.037	-0.009	0.005	-1.67	0.095
Age^2	0.001	0.0002	0.0001	2.83	0.005*
$Z_{\text{Males vs. Females}}$	-0.410	-0.094	0.036	-2.64	0.008*
Standard of living index (SLI)	-0.006	-0.001	0.007	-0.21	0.837
$E_{\text{Illiterates vs. Literates}}$	0.117	0.027	0.035	0.77	0.441
$D_{\text{LEG vs. HEG+}}$	0.749	0.172	0.033	5.22	0.000*
$F_{\text{Joint vs. Nuclear}}$	-0.478	-0.110	0.028	-3.94	0.000*
$Q_{\text{Smoker vs. Non-smoker}}$	0.173	0.040	0.034	1.18	0.238
$B_{\text{Alcoholic vs. Non-alcoholic}}$	-0.052	-0.012	0.036	-0.33	0.742
$S_{\text{Illness vs. No illness}}$	0.270	0.062	0.028	2.24	0.025*
Protein Intake	0.173	0.040	0.029	1.37	0.171
Constant	-0.450	-	-	-	-

§: Standard errors are robust.

Z, E, D, F, Q, B and S are Dummy variables for sex, education, economic status, family type, smoking habits, drinking habits and self-reported morbidity respectively.

+LEG = Low economic group; HEG = High economic group

*: $P<0.05$

= 0.172, $p < 0.001$). Morbidity also represents an important, albeit less influential, factor contributing to CED among Santhals, for those individuals who reported illnesses were found to have a 6.2% greater likelihood of developing CED relative to those who did not report any illness ($dy/dx = 0.062$, $p < 0.05$).

Discussion

One of the main purposes of the present paper is to understand the advantageous role, if any, of CED in forest dwelling indigenous (Santhals) population living under limited access to nutritional resources. A high prevalence (46.9%) of CED has been observed among the adult members of this ethnic group. Similar high occurrences of CED have also been reported amongst an array of neighboring tribal populations, such as the Shabars of Orissa (56.6%)[26], Mundas of Bankura, West Bengal (58.5%)[16], Kora Mudis of Bankura, West Bengal (52.2%)[3], Oraons of Jalpaiguri, West Bengal (39.4%)[4], War Khasis of Meghalaya (35.0%)[21] and Santals of Purulia, West Bengal (47.0%)[2]. Thus, it is evident from the above findings that overall the Santhals from Bankura District are marked by a lower prevalence of CED relative to neighbouring tribes from the same district (Bankura District: Munda and Kora Mudi), but when considered against other tribal populations of East-Central and Northeastern India their prevalence of CED may be considered moderate.

According to the WHO, it is normal for a relatively small proportion of thin individuals to be present within a population, but an excessive proportion of thin individuals may indicate the presence of food insecurity or the catabolic consequences of widespread infectious diseases[27]. As such, the proportion of a population with a low BMI (BMI<18.5) may reflect a population suffering from poor public health. In a normal population, the proportion of the population with low BMI is considered to range between 5% and 9%. On the other hand, a population in which greater than 40% possess a low BMI is defined as a population in a critical state of experiencing a very high prevalence of chronic energy deficiency[27].

Viewed from this perspective of predicting health from BMI data, the Santhals of Bankura district would be identified as facing a critical state of experiencing a very high prevalence of CED (46.9%). Yet, standing in opposition to this simplistic relationship between BMI and the overall health status of a population are the results obtained for mid-upper arm circumferences (MUAC) among the Santhals of Bankura District. Both Santhal males (0.2304m) and females (0.2241m) classified as CED have mid-upper arm circumferences that exceed the cut-off point suggested by James and others[28] for CED. Such anomalous results raise the possibility that the prevalence of low BMI in this population might not be the consequence of overall poor public health, but instead may have a different explanation.

It may be that the incidence of CED among members of this forest-dwelling indigenous population may have an adaptive function. As mentioned before, Santhals from this region of West Bengal reside in an area marked by challenging environmental conditions, and as a result, they are forced to exert considerable physical labor in order to wrest sufficient nutrition from cultivation in order to survive. Further, the sources of nutrition are considerably fewer in number[18]. Consequently, Santhals may have developed a »steady state« condition in which they maintain an energy balance, because they cannot afford to store energy for future usage due to scarcity of nutritional resources. Additionally, not too many centuries ago Santhals were primarily hunter-gatherers and even today, they still practice those activities as secondary occupation[17]. Hence, this forest dwelling ethnic community has been adapting and surviving successfully under scarce food supply for generations. Therefore, this »steady state« may explain why even though Santhals have lived under such harsh conditions for more than five centuries[17]; they have been able to maintain their nutritional status at the level of CED without converging to AED. In other words, developmental plasticity might have helped this population to survive and adapt to a limited supply of nutrients by changing its physiological and metabolic mechanisms. This explanation is in agreement with Barker's »thrifty phenotype« hypothesis explained earlier[7].

Further, it is observed that Santhals from this region are predominantly mesomorphic in their physique[29]. Maintenance of such body composition needs less nutritional requirement compared with an endomorphic and overweight body type. In addition, this fact that they are mesomorphic and not ectomorphic, supports the contention that despite their low BMI, they are not "starved", but have adapted physiologically to maintaining normal body composition (i.e., mesomorphy) despite low caloric intake.

Therefore, as James and other[28] suggested, this forest-dwelling indigenous population from Bankura District should be distinguished from at-risk underweight adults, for although they are thin, they may not be at risk. This assertion is further supported by the fact that difference in CED prevalence between Santhals by morbidity status is not statistically significant (Figure 1). Hence, it may not be correct to assume that low BMI will always equate with poor population health.

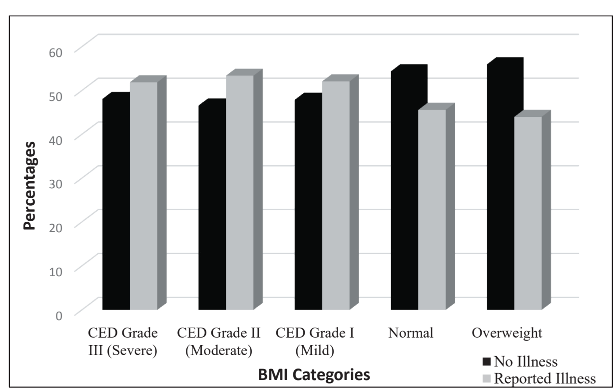

Fig. 1. Prevalence of CED according to SRM (Self-Reported Morbidity) among the adult Santhals of West Bengal.

Conclusion

The present paper is an attempt to draw attention to a possible adaptive explanation of a low BMI in the population under study. Nevertheless, for better understanding of this phenomenon we need similar studies on the neighbouring forest dwelling indigenous populations with high prevalence of CED. The limitation of this study is that the information on the maternal and child nutritional status is not available in the present data set.

Acknowledgements

I express my special gratitude to Prof. B.E. Hemphill from University of Alaska, USA and Dr. Mridu Prabal Goswami from IGIDR, India for their critical evaluations and valuable suggestions throughout this work. This work was supported by the Ministry of Tribal Affairs, Govt. of India.

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KRONIČNA ENERGETSKA DEFICIJENCIJA U POPULACIJI S OGRANIČENIM IZVORIMA PREHRANE

S A Ž E T A K

U radu se razmatra prevalencija kronične deficijencije energije, s naglaskom na važnoj ulozi socio-ekonomskih faktora, u populaciji Santala, plemenske zajednice u istočno-centralnoj Indiji. Presječno istraživanje obuhvatilo je 1262 odrasle osobe iz plemena Santal u pokrajini Bankura, u Zapadnom Bengalu u Indiji. Procjena prehrambenog statusa ukazala je na visoku prevalenciju (46,9%) pothranjenosti odrasle populacije Santala te statistički značajno veću učestalost u žena nego u muškaraca (dy/dx = -0.410, p = 0.008). Čini se da niži ekonomski status i morbiditet imaju ključnu ulogu u prevalenciji pothranjenosti u ovoj šumskoj populaciji. Međutim, stanje pothranjenosti u odrasloj populaciji Santala ne dovodi do povećanog rizika za javno zdravstvo. Stoga, s obzirom na prilagodbu, važno je, barem u ovoj populaciji, razlikovati mršave osobe od onih kod kojih postoji rizik od pothranjenosti.