

A Community Snapshot of Anthropometric Profile and Chronic Energy Deficiency among the Kols of Mirzapur District, Uttar Pradesh

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Abstract

Background: Chronic energy deficiency (CED) remains a significant public health concern among tribal populations in India, with recent national data indicating that Uttar Pradesh records one of the highest CED prevalence rates (45.7%) among adult tribal population. Despite India's tribal population comprising approximately 104 million individuals, health and nutritional data on many tribal communities, including the Kol remain limited. **Objective:** This study aimed to highlight the prevalence of CED among members of the Kol community in Mirzapur district, Uttar Pradesh, and to examine the association between socio-demographic factors and CED status. **Methodology:** A cross – sectional community – based study was conducted among Adults between March and April 2026. Around 48 households were surveyed using a structured questionnaire covering demographic and socio-economic variables, with household income categorized using the modified B.G Prasad scale. Height and weight were measured following standardized anthropometric protocols, and Body Mass Index (BMI) was calculated and categorized as per WHO standards. Associations between CED and gender were tested using Chi-square, Fisher's exact and independent sample t-test with significance set at $p < 0.05$. **Results:** Among participants, 65.2% had normal BMI, 23.7% exhibited CED (11.9% Grade I, 7.4% Grade II, 4.4% Grade III), and 11.1% were overweight or obese. CED prevalence was marginally higher among females (24.6%) than males (22.7%), but thus difference was not statistically significant ($\chi^2(4)=2.38$, $p=0.66$). **Conclusion:** The Kol community exhibits a moderate burden of CED alongside emerging overweight/obesity, reflecting a nutritional transition, occurring withing a context of low education and income.

Keywords: Chronic Energy Deficiency (CED), Body Mass Index (BMI), Nutritional Status, Socio-demographic factors, Anthropometry,

Introduction

Chronic energy deficiency (CED) refers to a state in which an individual experiences a prolonged phase of food consumption, whether in terms of calories, nutrients with respect to their energy usage in the body leading to a state of energy imbalances (Singh et al, 2024). While

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the Food and Agricultural Organization (FAO) defines CED “as a steady state” where an individual body is in the state of energy balance. When one is in such a state, the body mechanism in maintaining a balance between the energy input and the energy output (Shetty & James, 1994). India continues to grapple with severe undernourishment, heavy workload through high income and economic stability. Having a population of over one billion and most states still having fertility rate above the replacement level (World Bank, 2000). “Around 13% of the population in India suffer from Chronic undernourishment (Kaur, 2024). According to a recent report by NFHS-6, the Uttar Pradesh has one of the highest levels (45.7) of chronic energy deficiency (CED) among adult tribals in India (NFHS-6, 2026). Approximately 104 million tribesmen form India and the percentage is 8.6 of the total population of the country (Ministry of Tribal Affairs, 2022). Anthropometry is important in recording the nutritional value of a person and a society (WHO, 1995). Anthropometry has been suggested by WHO as an essential tool to evaluate the nutritional and health status of Tribal communities (WHO, 1995). Anthropometry is a fundamental tool used in measuring the nutritional status of the local communities, although it has its disadvantages in that the instruments used in anthropometry are easily transported to hard-to-reach places, where no modern technology can penetrate (Ghosh et al. 2001). These include the introduction of one such measure, which was suggested by most health scientists as that of Quetelet Index, or better known as Body Mass Index (BMI) (Keys et al, 1972). In other studies, BMI has been proposed as a sensible measure of obesity and adiposity (Keys et al. 1972 other inserts citations of your literature). BMI can be attributed to the work of a 19th century mathematician, by the name Adolphe Jacques Quetelet (Quetelet, 1842). Poor BMI and high rates of undernutrition is a major public health concern to poor communities in rural communities in developing countries (WHO, 1995). Other techniques can also measure the nutritional status of adult population but BMI has been most widely used due to its relatively low-cost structure, safety and applicability which enable it to achieve large scale survey (James et. al, 1994; Lee and Neiman, 2013). This renders BMI, the most reliable means of anthropometric evaluation of the nutritional conditions in adults (Lee and Nieman, 2013). Currently, low and middle countries are undergoing through a double burden of malnutrition, with overweight and obesity rates increasing swiftly in the developing countries (Aasheim & Shovik, 2011; WHO, 2017). The effects of having CED in adulthood may be devastating in both the life and body of an individual. It adds to the risk of morbidity and mortality. Minimal mental and cognitive growth results in poor physical and psychological accomplishment. The most common causes of CED are a bad diet, poor socio-economic status and infection. Today almost one out of every three people, suffer from either form of malnutrition and diet associated non-communicable disease (NCDs) (James et.al, 1994; Broca & Stamoulis, 2003; Rotimi et.al, 1999; Letamo & Navaneethan, 2014). Around 7.2% of adults in 2003 were under the category of underweight (Moore et.al, 2010). On the same note, 18.5% of adults in worlds underweight in 2014. Within this, 8.8% were comprised of men. A majority of these men (more than 20 percent) represented such nations as India, Bangladesh, Eritrea, Ethiopia, Afghanistan and Timor-Leste (NCD Risk factor Collaboration, 2016). Different studies have come to the realization that undernourished women stand a higher chance of giving low birth weight babies (Kramer, 1987; Bisai, 2004). The weight at birth is a significant parameter as it is used in predicting whether the neonates will survive and the health status of the mothers when they are pregnant (Baird, 1947; Gopalan, 1996). In developing nations like

India women are usually malnourished and their diet lacks adequate nutrients to forfeit the energy due to excessive physical activity. Majority of the women population in these countries were recorded to have a weight of less than 55kg, a standard set by WHO (Samuel et.al, 1992).

To this end, little information has been available on the nutritional status of the tribal Indian population in this regard as well as Chronic energy deficiency (Arlappa et.al, 2005; Bose & Chakraborty, 2005). As such, a need exists to report on nutritional profile of various tribal populations in India (Bose & Chakraborty, 2005).

The aim of the current project is to assess the prevalence of the CED in Mirzapur district in the Kol community. To find out the socio-demographic effects of CED among the study participants.

Materials and Methods

It was a cross-sectional study that was a community-based study that involved adult members in the Kol community in Gurgi Gram Panchayat in Mirzapur district in Uttar Pradesh, India. The district of Mirzapur is located approximately 294 km north east of Lucknow, the capital of the Uttar Pradesh, India. According to 2011 census, the district has a population of 2,496,970 of which 1,312,302 are males and 1,184,668 are females. The percentage of Schedule Caste in the total population is 661, 248 (26.48%) and Scheduled Tribe is 20,188 (0.81%). The literacy rate among male and females is 78.97% and 56.86% respectively. The Kols comprise 6.18% of the total population of Mirzapur district. This study was carried out from March 2026 to April 2026. Forty-eight households were surveyed with 135 male and female participants. Students over 18 years were included only. These data were collected through a validated questionnaire which collected the demographic variables including age, sex and socio-economic background of the household. Data on household head variables such as occupation, income, type of family, family size, housing characteristics was collected on the household level. Additional occupation, was only recorded in the household head as they were deemed to be the main earners in their homes and the most dependable on household related information. The revised B was used to classify household income into various groups. G Prasad Scale widely applied in India in rural communities globally in conducting Socio-economic classification. Measures of anthropometry including height and weight, were made using standard practices spelt out by Lohman et al. (1998). These scales were utilized to determine Body Mass Index (BMI) that was used as the main indicator of nutritional status and chronic energy deficit (CED). The Microsoft Excel and SPSS statistics software were used to analyze data. Demographic characteristics were summarized by means of descriptive statistics whereas the values of BMI were classified depending on the WHO standards in order to define the prevalence of CED. Inferential statistics were used to investigate the relationship between demographic factors and prevalence of CED. The checks performed were Chi square, Fisher's exact test and independent sample T- test. A p- value <0.05 was considered statistically significant for all tests.

Results

Table 1. Individual-level socio-demographic characteristics of study participants (N = 135)

Variable	Category	n	%
Sex	Male	66	51.1
	Female	69	48.9
Age (years)	18–25	9	6.7
	26–33	22	16.3
	34–41	57	42.2
	42–49	16	11.9
	50–57	12	8.9
	58–64	3	2.2
	65+	16	11.9
Educational status	Graduate	2	1.5
	High School	15	11.1
	Middle School	28	20.7
	Primary	44	32.6
	No Schooling	46	34.1

Table 2. Household-level socio-demographic characteristics (N = 48 households)

Variable	Category	n	%
Household income	Upper ($\geq$ ₹9,414)	1	2.1
	Upper Middle (₹4,707–9,413)	0	0.0
	Middle (₹2,824–4,706)	11	22.9
	Lower Middle (₹1,412–2,823)	24	50.0
	Lower ($\leq$ ₹1,412)	12	25.0
Family type	Joint	15	31.3
	Nuclear	33	68.8
House type	Kuccha	22	45.8

	Pucca	2	4.2
	Semi-pucca	24	50.0
Occupation	Artisan	18	37.5
	Agricultural daily wage	16	33.3
	Non- Agricultural labor	5	10.4
	Own cultivation/ farming	6	12.5
	Regular job	3	6.25

Table 1 and 2 shows the distribution of participants according to their socio-demographic characteristics. Household was also distributed according to the members of the family structure with 41.7% having 1-4 members and 41.7% having 5-7 members. Even the presence of high household number in population was declining with only 16.7 percent of the households consisting of family having over eight or more members. A large number of the households belonged to the nuclear families (68.8%), whereas joint families only comprised of 31.3%. Majority of the households were comprised of houses, that were either Kuccha houses (50.0%) or resided in Semi-pucca occupancies (45.8%). The households were categorized into different socio-economic groups according to the modified BG Prasad Scale, where in 50% of the households belonged to lower-middle income group (₹1412- ₹2823). This was then surrounded by 25% of these families under lower income category who earned less than 1412 per day. The substantial percentage of families was 22.9 in average income bracket (₹2824- ₹4706) and a very small percentage of households was 2.1 in upper income bracket (₹4707- ₹10000). The mean monthly household income across the population was about ₹11000 $\pm$ 4,569.79 per month with a median income of ₹10000. There was almost equal representation of males and females in the research population, with males occupying 51.1% of the population, and females taking 48.9% of the population respectively. The level of education within the community was observed to be low in general. Most of the respondents (34.1) were not inclined to any formal schooling, and they are closely followed by those respondents with only primary education at their disposal (32.6). Only 20.7 per cent of the population received an education at the Middle school level and only a fraction of 20.7 per cent went further to obtain education at the High school level. Only, 1.5 percent of the respondents responded that they had acquired graduate level education. Within the people actively engaged in occupation, artisans constituted the largest share of the community with 36.7%, further investigation also showed that majority of these workers were emigrating to bigger cities for occupation. Next people working in daily wage unemployment in the form of agricultural workers who comprised about 32.7% of the total population interviewed followed it. As few as 12.2% of the people were engaged in self-cultivation, and only 6.1% had regular jobs either. Only a small percentage (10.2) of the respondents were employed in a manual work like: Brick Killin, Masons, road builders, vendors, loaders and others.

Figure 1. Age distribution of study participants

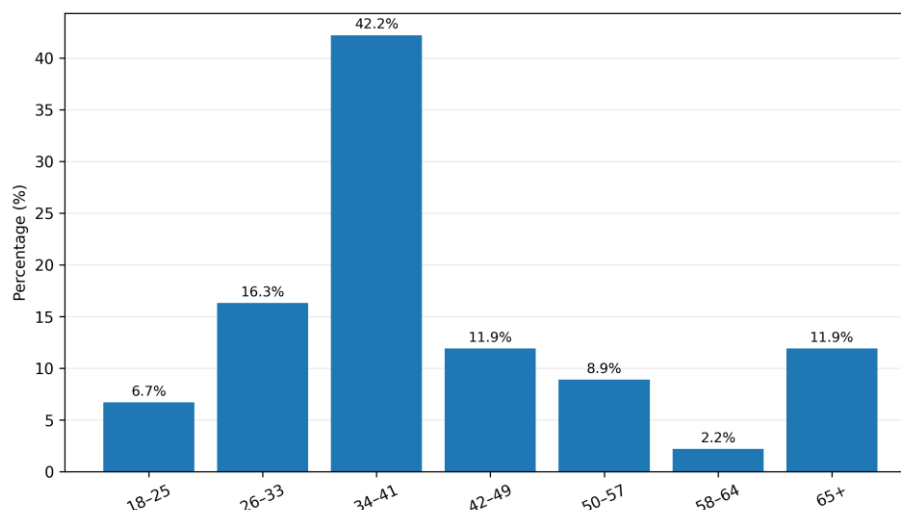


Figure 2. Educational status of study participants

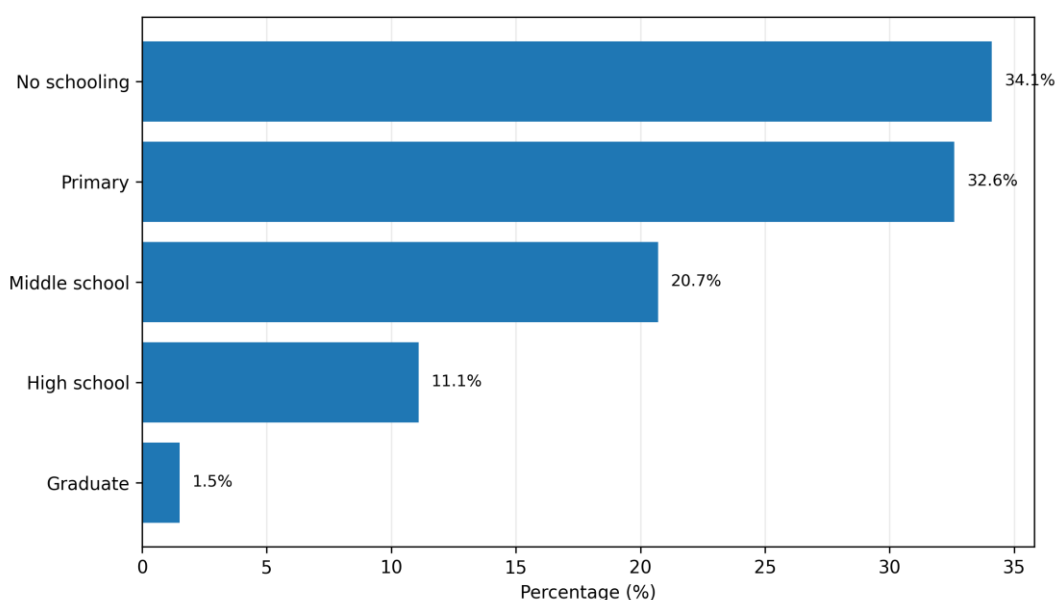
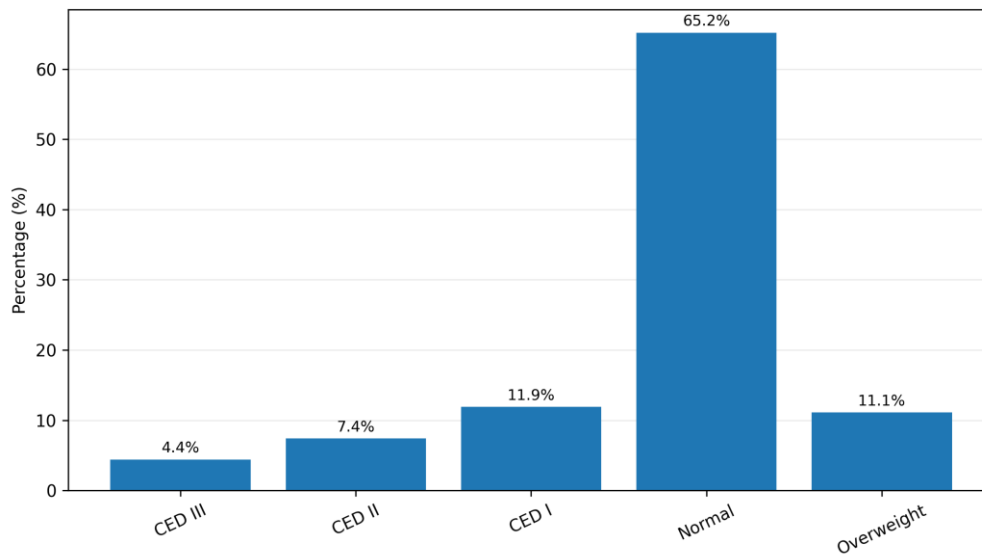


Table 3 – The distribution of participants according to BMI classification

Category	BMI (Kg/m ²)	Number	Frequency (%age)
CED- III	≤16.0	6	4.4
CED- II	16-16.9	10	7.4
CED- I	17.0-18.4	16	11.9
NORMAL	18.5-24.9	88	65.2
OVERWEIGHT	≥25	15	11.1
Total		135	100.0

Figure 3. Distribution of participants according to BMI classification

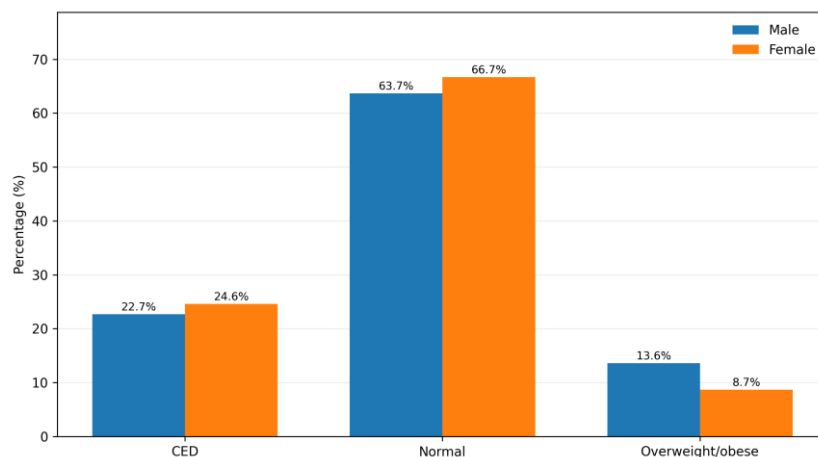


Out of the total of 135 measured, 65.2% reported to have normal BMI, which means that almost two-thirds of the study subjects were in a healthy nutritional position. Nevertheless 23.7% had been diagnosed with Chronic Energy Deficiency (CED) and 11.1% were classified as overweight or obese. Data on participants with CED revealed 11.9% Grade I CED, 7.4% Grade II CED, 4.4% Grade III CED.

Table 4: Comparison of CED categories and Gender.

Gender	CED	Normal	Overweight/Obese
Female (n=69)	24.6%	66.7%	8.7%
Male (n=66)	22.7%	63.7%	13.6%

Figure 4. Nutritional status by sex



The prevalence of CED among females was 24.6% and normal nutritional status was observed in 66.7% of the population and overweight or obese in 8.7% of the population. Among, males

22.7% were classified to CED category, 63.7 were to have normal category and 13.6 in overweight/obese category. CED was thus a bit more prevalent among the females (24.65) than it was in males (22.7%). On the other hand, a higher percentage of males (13.6) than females (8.7) were overweight or obese. There was a relatively similar Proportion with normal nutritional status between males (63.7%), and females (66.7%). On the whole, the results reveal that CED is comparatively prevalent among both genders, yet a slight higher among females than male population.

Figure 5. BMI classification by sex

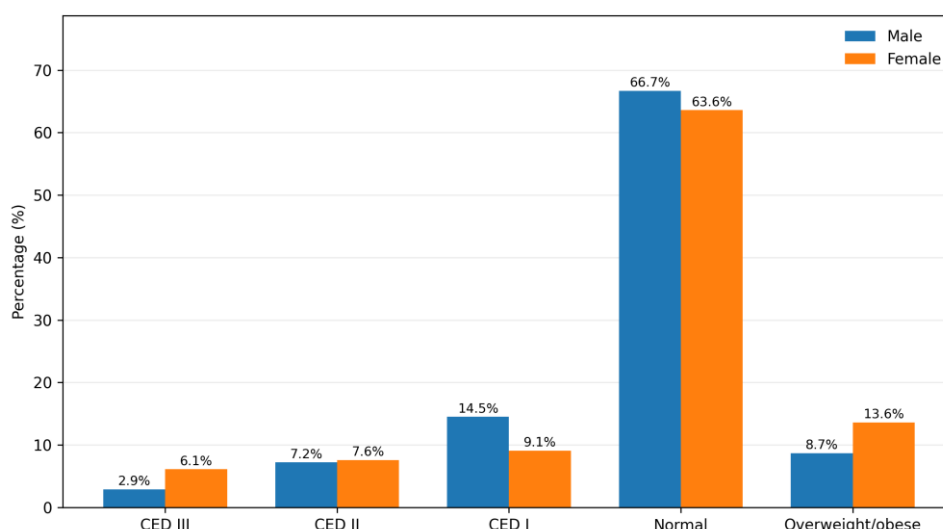


Table 5: Chi-square analysis to assess the association between CED and Gender.

Category	BMI (Kg/m ²)	Male	Female	Total
CED- III	≤ 16.0	2 (2.9%)	4 (6.1%)	6 (4.4%)
CED- II	16.0-16.9	5 (7.2%)	5 (7.6%)	10 (7.4%)
CED- I	17.0-18.4	10 (14.5%)	6 (9.1%)	16 (11.9%)
NORMAL	18.5-24.9	46 (66.7%)	42 (63.6%)	88 (65.2%)
OBESITY/O BESE	≥ 25.0	6 (8.7%)	9 (13.6%)	15 (11.1%)
TOTAL		69 (100.0%)	66 (100.0%)	135 (100.0%)
$\chi^2(4) = 2.383, p = 0.666 (p < 0.05).$				

The participants were tested in the Gender-wise distribution of the BMI categories. Of the total participants, 69 (51.1%) were females and 66 (48.9%) were males. All the participants were overweight with a normal BMI of 65.2% and 23.7% of the participants were in the normal BMI versus the proportion of those with chronic energy deficiency (CED), Grade III CED, Grade II CED and Grade I CED, respectively. An additional 11.1% of respondents were considered to be overweight/obese. Despite, the fact that, descriptive differences were noted whereby, CED was a little more prevalent among females than their male counterparts, there were no statistical differences associated with gender and BMI. Pearson Chi-square test did not reveal any significant correlation, [2.383, 4, p 666). The Fisher-Freeman halton accuracy test was also taken into consideration and it also revealed no statistically significant correlation ($p=0.688$). The Likelihood- ratio test also yielded similar results ($\chi^2(4) = 2.410$, $p = 0.661$; exact $p = 0.683$). The result was also small in terms of the effect size as shown by Cramer V test= 0.133.”

Discussion

The current research records a moderate prevalence of Chronic energy deficiency (CED) where there was a large percentage of adults with normal BMI along with a small but not insignificant percentage of them being overweight or obese among the Kol population of Gurgi gram panchayat, Mirzapur district, Uttar Pradesh. In general, the results show that though undernutrition is still an acute issue of public health, the nutritional situation of this tribal group is diverse and implies a continuation of the change in the patterns of body weight.

The assignment of the BMI categories would signify that, in the paradigm of public-healths the Kol community in Gurgi is being subjected to a severe but not extreme energy deficit in terms of WHO threshold of prevalence of low BMI among adult populations (Nuttall, 2015); mutually-existing malnutrition in a comparatively marginalized rural tribal setting. The social-demographic conditions of the sample population, low levels of formal schooling, polarization of the population between lower and lower-middle income levels, nuclear family structure, and artisanal and casual forms of wage labor are all a case of structure deprivation, traditionally accompanied by the high risk of chronic undernutrition. (Adak et al., 2006; Sengupta & Syamala, 2012). In this environmental context, the preservation of normal BMI in approximately two- thirds of participants, could be a result of an intricate interaction of energy input, high levels of energy expenditure and compensatory physiological alterations as mentioned in previous research on CED (Kaushik et al., 2026).

Relative to the available general anthropometric data base on Indian tribal population, it appears that the occurrence of CED is lower in Kols compared to most of the east Indian and central Indian communities. Where CED rates fall in the high (20-40%) to very high ($\geq 40\%$) (Bharati et al., 2007; Tripathi et al., 2023). Scattered reports of community surveys in West Bengal and Odisha, among others, have indicated CED prevalence rates of approximately 30-35 percent in the adult male population and 32-36 percent in the adult female population indicating that there is indeed a severe nutritional stress situation in these states (Bharati et al., 2007; Bisai and Bose, 2006; Bose and Chakraborty, 2005; Das and Bose, 2010). Comparatively, the CED of the Kol community was closer towards the “serious category and slightly lower than the NFHS- recommended estimates of energy deficiency among tribal men and women in Uttar Pradesh on the whole and there was an indication of intra-tribal variation in the nutritional

status. Such relative changes can be attributed to the local livelihood systems, migration aiming at settling in the profession and chances to acquire different sources of foods.

Concurrently, the Kols exhibit some prominent similarity with other tribal groups, such as reduced levels of education and their low pay which earlier researches had singled out as being key determinants of underfeeding and reduced working capacity. And these, current as they now are, reiterate the same appeals in the form of Kol community.

Descriptively, the village under study had slightly higher CED in women compared to men, overweight and obesity was slightly higher in men compared to BMI but the point of difference of BMI and gender differences was minimal and the effects of this difference small. The trend diverges with various studies that have been conducted in east and central India, where female adults, especially santal women have been observed to have much higher CED prevalence in comparison to males and have large sex differentials (Bose et al., 2006; Bose and Chakraborty, 2005, 2005; Ghosh, 2017; International Institute for Population Sciences, 2026). Lack of statistically significant association between BMI and other issues may be linked to the small sample size, and context specific division of labor and food distribution. Male labor migration is also a possibility and the diversities of the source of income have muted sex disparities in the energy imbalance among the participants.

Another analysis, also brings in the birth of an overweight sample, in a tribal group, which is relatively deprived, which is worth mentioning under the topic of a growing dual loss of malnutrition in India. NFHS data have been able to show that though the prevalence of underweight in the marginalized communities remains the norm, overweight/obesity also entered the scene with some states such as Delhi, Punjab and Kerala showing a high prevalence of overweight both in the rural and urban diasporas at low SES. On the same background, the existence of overweight/obesity among Kols indicate that, nutrition transition has just started to make its mark in small percentages; probably by affecting dietary habits, less energy burnt in certain occupations or contact with energy rich-low-cost food products.

Conclusion

The current paper gives the initial evidence regarding the nutritional condition of the Kol community in Gurgi gram panchayat, Mirzapur through the BMI in determining the Chronic energy deficiency (CED). Although most adults (2/3) lived with a normal BMI, almost a quarter had CED and just one out of 10 were overweight and obese, which indicates a heterogeneous nutritional landscape with both the prevalence of undernourishment and overnutrition. The difference in geometry between both genders in categories of BMI were very weak and not significant indicating that there is no substantial difference in the measures of nutritional risk of the Kol population.

When contrasted with the current tribal health documentation the Kol community seems to be experiencing a pressing, but not a precarious problem, with lower prevalence of under nutrition, compared to many other tribal communities in the central and eastern parts of India. Their lack of education, under-pay and over-projectile on the manual and crafty work force can be credited with existing vulnerability. These results lead to the conclusion that there is a great need to have comprehensive and contextual evaluation that could be involved in managing the

augmented degrees of nutritional deficiency in the populace. The research, also, bridges a huge gap in the tribal community of Uttar Pradesh, and is the cornerstone of longitudinal and multi-dimensional researches, on public-health and socio-economically empowered research.

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