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Nutritional status and Health related issues among the rural women of Karbi Anglong, Assam (India)

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ABSTRACT

Women are generally vulnerable to undernutrition especially during pregnancy and lactation where the food and nutrient requirements are more during that period. The demographic consequences of the lower status in women have found expression in various forms such as female infanticide, higher mortality rate for women compared to men, lower sex ratio, literacy rate in female, lower level of employment of women as compared to men. The present investigation attempts to understand the health and nutritional status among indigenous Karbi tribal women of Karbi Anglong, Assam, Northeast India. The present community based cross-sectional investigation was undertaken among 150 Karbi women (aged 20-49 years) residing in rural areas of Diphu, Karbi Anglong Assam, using stratified random sampling method. Data on the anthropometric, socio-economic and demographic variable were collected using pre-structured questionnaire. Anthropometric measurements of weight and height were recorded using standard anthropometric procedures and Body Mass Index (BMI) was calculated using equation, $BMI=Weight/Height^2$ kg/m^2. The nutritional status was assessed using proposed BMI classification for Asia Pacific population (WHO, 2000). The overall prevalence of obesity, overweight and undernutrition was observed to be 34.00%, 16.67% and 10.67%, respectively. The total prevalence of abortion or miscarriage and still births were observed to be 18.66% and 9.33%, respectively. Prevalence of abortion and still births were observed to be higher among obese women ($p>0.05$). Several socio-economic and demographic factors were not significantly associated with the nutritional status ($p<0.05$). There is scope of necessary improvement of the present health and nutritional status by introducing appropriate healthcare intervention strategies among women.

Keywords: Anthropometry, Health, Karbi tribe, Nutrition Status, Northeast India.

INTRODUCTION

Assessment of the nutritional status gives an opportunity to understand the overall health status of an individual or populations. Poor/inadequate nutritional status can readily make the individual susceptible to suffer from several infectious diseases which reduce their physical activity, productivity and also lead to poor reproductive outcomes (WHO, 1995; Belachew et al., 2008). Moreover, over the past decades several initiatives have been taken into consideration to improve the nutritional situation among the vulnerable segments of the population (Development Initiatives, 2018). Maternal mortality, infant mortality, child marriage, cervical cancer and female genital mutilation are some of the serious health issues women have to face in the developing nations (Akter et al., 2018; Hammad et al., 2018; Skrundevskiy et al., 2018; Medhi et al., 2018; Patel et al., 2018). Malnutrition is considered to be the major driver of the global health burden of both communicable and non-communicable diseases in population. India is a country with enormous population size, genetic and ethnic variations and socio-economic disparities (Kumar et al., 2013; Narayan et al., 2019) and despite of the relatively high economic growth rate in past few years, over one-third of the population of the malnourished (i.e., undernutrition) children of the world lives in India (Varadharajan et al., 2013; Development Initiatives, 2018) and people are living with poverty, poor dietary quality associated with poor childhood growth as well as micronutrient deficiencies (Chandra and Ray, 2002; Allen, 2010; Varadharajan et al., 2013; Rao et al., 2016). Recent studies have shown a significant proportion of the populations suffering from overweight and obesity coupled with burden of several non-communicable diseases (e.g., hypertension, cardiovascular diseases, diabetes and osteoarthritis) in Indian population (Subramanian and Smith, 2006; Subramaniam et al., 2007; Mungreiphy and Kapoor, 2010; Sen et al., 2013; Rengma et al., 2015; Mondal et al., 2017; Tigga et al., 2018). Therefore, the existing trend has shown that the individuals/populations are suffering from undernutrition (e.g., chronic energy deficiency or CED) and at the same time has also shown the prevalence of overweight and obesity; thus the existence of a double burden of malnutrition (DBM) (e.g., Subramanian et al., 2007; Sengupta et al., 2014; Kulkarni et al., 2017; Dutta et al., 2019). Several researches have reported that currently, most of the developing countries of the world have a significant number of individuals are suffering from the DBM due to nutritional transition, socio-economic transition, urbanization, migration, and change in the food habits and sedentary lifestyle patterns (Friere et al., 2014; Rengma et al., 2015; Luhar et al., 2018; Prentice, 2018). Recent research investigations have reported the existence of prevalence of

DBM among Indian children and adults including adolescence and women in reproductive ages in population (Sengupta et al., 2014; Sharma and Mondal, 2014; Mondal et al., 2015, 2017; Kulkarni et al., 2017; Tigga et al., 2018; Young et al., 2019). However, in most of the cases, policy makers have given emphasis on the undernutrition and failed to address the severity of overweight and obesity in population in India (Friere et al., 2014). Several studies have reported that the magnitude of overweight and obesity is now increasing at an alarming rate among children and adults including women belonging to reproductive age groups in India (Subramanian et al., 2007; Mungreiphy and Kapoor, 2010; Sengupta et al., 2014; Rengma et al., 2015; Kulkarni et al., 2017; Bharali et al., 2017; Chowdhury et al., 2018; Luhar et al., 2018; Dutta et al., 2019; Young et al., 2019; Zhou et al., 2019).

Recent research studies indicates an increased in the prevalence of several non-communicable diseases including hypertension, cardio-metabolic disorder, cancer as well as high reproductive risks (e.g., miscarriage, anemia, still-birth and birth defects) among women due to overweight and obesity in population (Cardozo et al., 2012; Beavis et al., 2015; Okeh et al., 2015; Arnold et al., 2016; Zhou et al., 2019). In the last few decades changes in socio-economic conditions, food consumption patterns and sedentary lifestyle have increased the overweight and obesity prevalence among women which has led to high morbidity and series of evolution of several non-communicable diseases including cancer and reproductive health complications (e.g., Cardozo et al., 2012; Beavis et al., 2015; Rengma et al., 2015; Okeh et al., 2015; Arnold et al., 2016; Tigga et al., 2018). Women are residing in rural regions subjected to various socio-cultural and demographic disparities, nutritional status and inequality (e.g., food and resource allocation, gender role, and utilization of health-care facilities) in India. Therefore, women's poor health status keeps them inferior to men and compels them to suffer from various infectious diseases and reproductive health risks [e.g., maternal mortality, miscarriage, anemia, still-birth, intra-uterine growth retardation or low-birth-weight (LBW) and physical weaknesses] thereby making the women less productive which can affect household economic well-being. It has been observed that the dietary intake of rural women or pregnant women was lower than the recommended level that may trigger the prevalence of undernutrition (e.g., CED) and micronutrient deficiencies (e.g., zinc, iron, magnesium, folic acid and iodine) among women (e.g., Pathak et al., 2004; Durrani and Ravi, 2011; Herter-Aeberli et al., 2016; Shankar et al., 2019). It is attributed to the existence of high illiteracy and economic dependability, lack of awareness, unavailability and inaccessibility, gender and regional (e.g., rural) disparities and cultural preferences have effect on the nutrition and health status of the women. Therefore, the assessment and

evaluation of health and nutritional status became imperative among vulnerable segments of population. The objectives of the present investigation are to assess the prevalence of under and over-nutrition and health related issues of the rural tribal women and to find out the associations with several socio-economic and demographic factors with under and over-nutrition status.

MATERIAL AND METHODS

The present cross-sectional investigation was conducted among 150 Karbi tribal women of the Diphu, Karbi Anglong district of Assam in the age group of 20-49 years. The district Karbi Anglong ($25^0$33′N to $26^0$35′N latitude and $92^0$10′E to $93^0$50′E longitude) is the largest district amongst the 33 districts of the state of Assam and covers an area of 10,434 km^2 of Assam, Northeast India**.** According to National Census, 2011, the district had population of 956,313 (490,167 male; 466,146 female) with sex ratio of 951 per 100 male and average literacy rate 69.25 (76.14% male; 62.00% female). The district has residence of mainly indigenous tribal population, predominantly Karbi tribe and tribal population including Dimasa, Bodo, Rengma Naga and heterogeneous caste population. Ethnically, the Karbi's are an endogamous tribal population belonging to the Tibeto-Mongoloid population and the Tibeto-Burman linguistic family (Das et al., 1987). They contribute a large segment to the social and economic well-being of the state and of the country as a whole. Therefore, it becomes imperative to assess and report the nutritional conditions of this indigenous tribal population of Assam, Northeast India. The ethnicity and age of the research participants were recorded through the birth certificates or relevant documents issued by Government. The data were collected through the stratified random sampling methods. The research participants in the present investigation were homogeneous in nature mainly collected among the indigenous Karbi tribal population. Research participants with disease and physical deformities were excluded from the investigation to avoid sample selection biasness. A total 160 individuals were approached, out of which 150 research participants were voluntarily participated in the present investigation. The overall participation rate was found to be 93.75%. The detail aims and objectives of the present investigation and procedures of data collection were explained and informed consent was obtained before the participation. The data collection was done mainly through the household survey using pre-structured questionnaire. The present investigation was conducted in accordance with the ethical guidelines for human experiments, as laid down in the Helsinki Declaration of 2000 (Touitou et al., 2004).

Collection of Socio-economic and Demographic Variable

A pre-structured questionnaire was used to collect the socio-economic and demographic data using both open and close ended questionnaire. The data including the age, occupation, education, religion, living conditions, marital status, house types, living rooms, number of living children and number of miscarriages or abortions were collected. Special care was taken during the briefing the research questions and in order to obtained the correct response from the respondents. The data were collected in the respective household by face-to-face interviewing the research participants.

Collection of the Anthropometric Measurements

Anthropometric measurements of height and weight were recorded using standard anthropometric procedures (Hall et al., 2007). Height of the subjects was recorded to the nearest 0.1 cm with the help of an anthropometer rod with the head held in the Frankfort horizontal plane. Weight was taken wearing minimum clothing and with bare feet using a portable weighing scales to the nearest 0.5 kg. Measurements were taken with ample precision for avoiding any possible systematic errors of anthropometric data collection (e.g., instrumental or landmarks) (Harris and Smith 2009). Intra-observer and inter-observer technical errors of the measurements (TEM) were calculated to determine the accuracy of the anthropometric measurement using the standard procedure of Ulijaszek and Kerr (1999). For calculating TEM, height and weight were recorded from a different data set of 30 women other than those selected for the investigation by the authors (JS and NM). $TEM=\sqrt{(\Sigma D^2/2N)}$ [D= Difference between the measurements, N=Number of individuals measured]. The co-efficient of reliability (R) of the anthropometric measurements were calculated from TEM using the following equation: $R=1-(TEM)^2/SD^2$[SD=Standard deviation of the anthropometric measurements].The coefficient of reliability (R) of the measurements was calculated for testing the reliability of the measurements. Very high values of R were obtained for height and weight and these values were observed to be within the recommended cut-off values of 0.95 (Ulijaszek and Kerr, 1999). Hence, the anthropometric measurement recorded by JS was considered to be reliable and reproducible. All the measurements in this present study were subsequently recorded by JS.

Assessment of the Nutritional Status

The assessment of nutritional status was done by calculating the standard measure of Body Mass Index (BMI). The BMI was calculated using the standard equation of the World Health Organization (WHO) (WHO, 1995, 2000): $BMI=Weight/Height^2$ (kg/m^2). The overall nutritional status was estimated in terms of undernutrition or chronic energy deficiency

(CED), overweight and obesity among the populations by using standard values recommended by WHO (2000). The BMI<18.50 kg/m^2, BMI 23.00-24.99 kg/m^2 and BMI ≥25.00 kg/m^2 was considered to be CED, overweight and obese (WHO, 2000). Several research investigations have reported these proposed cut-off points to determine the nutritional status in Indian population (Sen et al., 2013; Sengupta et al., 2014; Rengma et al., 2015; Bharali et al., 2017; Mondal et al., 2017; Tigga et al., 2018). Cases of abortions or miscarriages and still births are to be associated with the poor health conditions of the Karbi women in the present investigation. The history of abortion or miscarriage and still birth are also taken into consideration using recall method among Karbi women. The socio-economic status (SES) was evaluated using a modified version of the scale of the Kuppuswamy's (Kumar et al., 2007). The scale determines the SES based on a score calculated from education, occupation and monthly income. It was observed that all the women's in the present study belonged to the low to middle income groups.

Statistical Analysis

Statistical analyses were done using the Statistical Package for Social Sciences (SPSS, Inc., Chicago, IL; version 16.0). The anthropometric measurements were depicted in terms of descriptive statistics [mean ± standard deviation (SD)]. One way analysis of variance (ANOVA) was done to assess the age-specific mean difference in anthropometric variables. Chi-square (χ^2) analysis was used to assess age-specific differences in the prevalence in different nutritional categories of undernutrition, overweight, obesity and certain socio-economic and demographic variables obtained in this investigation. The χ^2-analysis was also done to determine the differences in different nutritional categories with abortion and still births. A p-value of <0.05 was considered to be statistically significant.

RESULTS

Descriptive statistics of Anthropometric Variables

The age-specific subject distribution, descriptive statistics (mean± SD) and 95% CIs of weight, height and BMI among the tribal Karbi married women are shown in Table 1. The overall mean of height, weight and BMI were observed to be 154.64±6.29 cm, 51.06±7.88 kg, and 23.74±3.69 kg/m^2, respectively. The comparisons of age-specific mean values showed that weight, height and BMI were observed to be higher among the participants aged 30-39 years followed by 40-49 years. The lowest age-specific values were obtained among those aged 20-29 years. The age-specific mean BMI was ranged from 21.34±2.91 kg/m^2 to24.47±4.01 kg/m^2 among Karbi women. Using ANOVA, the age-specific mean differences

in anthropometric variables of weight (F=11.64, $p<0.01$) and BMI (F=9.87, $p<0.01$) were differ significantly across the age groups but the difference was observed to be statistically not significant in height (F=1.93, $p>0.05$) (Table 1).

Prevalence of undernutrition and overweight-obesity among Karbi women

The age-specific and overall prevalence of undernutrition, overweight and obesity among Karbi tribal women is depicted in Table 2. The overall prevalence of undernutrition (BMI≤18.50 kg/m^2), overweight (BMI>23.00-24.99 kg/m^2) and obesity (BMI>25.00 kg/m^2) were observed to be 10.67%, 16.67% and 34.00%, respectively. The age-specific prevalence of undernutrition, overweight and obesity was found higher in 20-29 years (15.56%), 40-49 years (22.64%) and 30-39 years (46.15%), respectively. The age-specific lower prevalence of undernutrition, overweight and obesity was observed to be higher in the age group of 30-39 years (5.77%), 20-29 years (11.11%) and 20-29 years (15.56%), respectively. Using χ^2-analysis, the age-specific differences in the prevalence of undernutrition (χ^2-value=2.00), overweight (χ^2-value=1.72) and obesity (χ^2-value=5.60) was observed to be statistically not significant ($p>0.05$) (Table 2).

Table 1: Descriptive statistics (mean± standard deviation) of the anthropometric variables among Karbi women of Karbi Anglong, Assam

Variables	20-29 years (N=45)	30-39 years (N=52)	40-49 years (N=53)	Total (N=150)	F-value	*P*
Height (cm)	154.64±6.29	156.35±5.77	156.64±3.96	155.94±5.40	1.93	0.150
Weight (kg)	51.06 ±7.88	59.99±11.23	58.23 ±9.02	56.69 10.20	11.64	0.000
BMI(kg/m^2)	21.34±2.91	24.47±4.01	23.74±3.69	23.27±3.80	9.87	0.000

Table 2: Prevalence of undernutrition, overweight and obesity Karbi women of Karbi Anglong, Assam

Nutritional status	20-29 years (N=45)	30-39 years (N=52)	40-49 years (N=53)	Age-specific differences (χ^2- analysis)	Total (N=150)
Undernutrition (≤18.50 kg/m^2)	7 (15.56)	3 (5.77)	6 (11.32)	2.00*	16 (10.67)
Normal (18.50-22.99 kg/m^2)	26 (57.78)	17 (32.69)	15 (28.30)	4.20*	58 (38.67)
Overweight (23.00-24.00 kg/m^2)	5 (11.11)	8 (15.38)	12 (22.64)	1.72*	25 (16.67)
Obese (≥25.00 kg/m^2)	7 (15.56)	24 (46.15)	20 (37.74)	5.60*	51 (34.00)
Values are in parenthesis indicates percentage, *d.f., 2; p>0.05					

Distribution of socio-economic and demographic variables with undernutrition and overweight-obesity

The distribution of the socio-economic, demographic and lifestyle variables with the prevalence of undernutrition, overweight and obesity of the Karbi women is depicted in Table 3.The prevalence of obesity (36.72%) was found to be higher among 'Housewife' occupation category, but the undernutrition (13.64%) and overweight (22.72%) was observed to be higher in women belonging to the 'Service' category. Similarly, women with $\geq 9^{th}$ standard education had higher prevalence of undernutrition (12.99%) and overweight (16.88%), but obesity (40.00%) was observed to be higher in $\leq 8^{th}$ standard education category. As per as living condition are concern, the magnitude of undernutrition (11.36%) was higher among women living in bricked house types, but the overweight (17.92%) and obesity (36.79%) prevalence was observed to higher in non-bricked categories, respectively. The prevalence of undernutrition (12.96%) and obesity (42.59%) was observed to be higher among women having ≥3 number of living children but the overweight (20.00%) was found to be higher among women having '2 number' of living children. The nutritional status did not shown any specific trend with number of living room, but the prevalence of undernutrition (19.05%), overweight (15.87%) and obesity (42.42%) was found higher among women with ≤2 number, 3 number and ≥4 numbers of living rooms, respectively. Using χ^2-analysis, the differences in the prevalence of undernutrition, overweight and obesity in socio-economic and demographic variables were found to be statistically not significant ($p>0.05$) (Table 3).

Age-specific prevalence of abortions and still-births among Karbi women

Age-group specific frequency distribution of abortions and still-births among Karbi tribal women is depicted in Table 4. The overall prevalence of abortion and still-births among the Karbi women was observed to be 18.67% and 9.33%, respectively. Prevalence of abortion is highest in the age group of 30-39 (21.15%) followed by 40-49 years (20.75%) and finally 20-29 years (13.00%). The age-specific still-birth is observed to be highest in the age-group of 40-49 years (13.20%) followed by 30-39 years (7.69%) and finally 20-29 years (6.66%) indicating poor health status among the women in the present investigation. Using chi-square analysis, age-specific prevalence was observed to be statistically not significant in number of abortion ($\chi^2=0.85$, d.f., 2; $p>0.05$) and still-birth ($\chi^2=1.21$, d.f., 2; $p>0.05$) among Karbi women (Table 4)

Table 3: Socio-economic demographic variables and prevalence of undernutrition, overweight and obesity among rural women of Karbi Anglong, Assam

Variable		Frequency (N=150)	Undernutrition (N=16)	Overweight (N=25)	Obesity (N=51)
Occupation	Housewife	128(85.33)	13 (10.16)	20(15.63)	47(36.72)
	Service	22(14.67)	3 (13.64)	5(22.72)	4(18.18)
	χ^2-Value		0.19*	0.47*	1.57*
Education	Illiterate	48(32.00)	4 (8.33)	8(16.67)	16(33.33)
	<=8th standard	25(16.67)	2 (8.00)	4(16.00)	10(40.00)
	>=9th standard	77(51.33)	10 (12.99)	13 (16.88)	25 (32.47)
	χ^2-Value		0.72*	0.01*	0.23*
House type	Bricked	44(29.33)	5 (11.36)	6 (13.64)	12 (27.27)
	Non-bricked	106(70.67)	11 (10.38)	19 (17.92)	39 (36.79)
	χ^2-Value		0.03*	0.30*	0.64*
Living children	0-1	51 (34.00)	6 (11.76)	8 (15.69)	13 (25.49)
	2	45 (30.00)	3 (6.67)	9 (20.00)	15 (33.33)
	≥3	54 (36.00)	7 (12.96)	8 (14.81)	23 (42.59)
	χ^2-Value		0.92*	0.37*	1.69*
Living rooms	≤2	21(14.00)	4(19.05)	6(2.86)	8(3.81)
	3	63(42.00)	6(9.52)	10(15.87)	15(23.81)
	≥4	66(44.00)	6(9.09)	9(13.64)	28(42.42)
	χ^2-Value		1.37*	1.73*	2.60*
Values in parenthesis indicate percentages, *p>0.05					

Table 4: Data related to miscarriage and still birth according to age among Karbi women of Karbi Anglong, Assam

Age	Number of Abortions	Number of still-births
20-29 years (N=45)	6 (13.33)	3 (6.67)
30-39 years (N=52)	11 (21.15)	4 (7.69)
40-49 years (N=53)	11 (20.75)	7 (13.21)
Total (N=150)	28 (18.67)	14 (9.33)
χ^2-Value	0.85*	1.21*
Values are in parenthesis indicates percentages, *>0.05		

Nutritional status-wise distribution of abortion and still birth among Karbi women

The overall frequency distribution of number of abortions and still-births according to different nutritional categories among Karbi tribal women is depicted in Table 5. The higher prevalence of number of abortion (23.53%) and still birth (11.76%) was observed in obese

Karbi women. The frequency distribution of number of abortion and still birth was observed to be slightly lower in overweight (abortion-16.00%; still birth-8.00%) category than normal (abortion-18.97%; still birth-8.62%) nutritional status women. Using χ^2- analysis, the difference in the frequency distributions of number of abortion (χ^2- value=1.85, d.f., 3) and still birth (χ^2- value=0.52, d.f., 3) in different nutritional categories were observed to be statistically not significant among Karbi women ($p>0.05$) (Table 5).

Table 5: Prevalence of undernutrition, overweight and obesity in relation to number of abortion and still birth among Karbi women of Karbi Anglong, Assam

Nutritional status (N=150)	Undernutrition (≤18.50 kg/m^2) (N=16)	Normal (18.50-22.99 kg/m^2)(N=58)	Overweight (23.00-24.00 kg/m^2)(N=25)	Obese (≥25.00 kg/m^2)(N=51)	χ^2-analysis
Number of abortion [N=28 (18.67)]	1 (6.25)	11 (18.97)	4 (16.00)	12 (23.53)	1.85*
Number of Still Birth [N=14 (9.33)]	1 (6.25)	5 (8.62)	2 (8.00)	6 (11.76)	0.52*
Values are in parenthesis indicates percentage, *p>0.05					

DISCUSSION

The world nutritional scenario suggests a DBM nutritional status that is undernutrition and over-nutrition as well as obesity. Environmental conditions and household patterns including rural habitat and sanitation found to have great influence on the undernutrition (Harrador et al., 2014; Keino et al., 2014; Tigga et al., 2018). The change in the dietary patterns including sedentary lifestyles contributes significantly to the overweight and obesity in the populations. The prevalence of undernutrition is considered to be a greater risk factor for intrauterine growth retardation or LBW (<2500 gm) (Victora et al., 2008; Sen et al., 2010; Dey et al., 2019). India has one of the highest rates of undernutrition burden with significant sign of increasing overweight-obesity in urban population, but recent nutrition transition showed a higher risk of overweight and obesity is evident in the rural setting in India, especially among women and individuals belonging to high socio-economic status group (Subramanian and Smith, 2006; Subramanian et al., 2007; Mungreiphy and Kapoor, 2010; Sen et al., 2013; Sengupta et al., 2014; Rengma et al., 2015; Kulkarni et al., 2017; Dutta et al., 2019). At the same time, a high prevalence of underweight persists, resulting in a

significant prevalence of DBM in Indian population (Sengupta et al., 2014; Kulkarni et al., 2017; Tigga et al., 2018; Jayalakshmi and Kannan, 2019). Recent studies have reported the high prevalence of overweight and obesity among Indian women (Subramanian et al., 2007; Mungreiphy and Kapoor, 2010; Sen et al., 2013; Sengupta et al., 2014; Rengma et al., 2015; Sinha et al., 2018; Tigga et al., 2018). Furthermore, the high prevalence of undernutrition among women and its associations with mortality and morbidity are very common phenomenon in most of the developing countries including India (Rengma et al., 2015; Mondal et al., 2017; Tigga et al., 2018). Anthropometry is a widely used, easy and reliable technique in assessing nutritional status in adult populations in field and epidemiological investigation (WHO, 1995; 2000). Nutritional status assessment plays an important role in the overall health status as well work capacity, physical activity and reproductive performances of women and the health of their children (e.g., <5 years) (WHO, 1995; Black et al., 2008). The present investigation showed a very high rate of undernutrition, overweight and obesity among the women which implies a very poor nutritional status among the Karbi women. The overall undernutrition, overweight and obesity level are 10.67%, 16.67% and 34.00% respectively (Table 2). Education plays a very important role in the prevalence of undernutrition among the populations. Illiteracy imposes undernutrition among the people due to lack of dietary knowledge as well lack of awareness about health. Foods rich in fats as well as loss of physical activity also cause overweight and obesity among the population. Socio-economic conditions such as house patterns, demographic factors may also have impact on the nutritional status (e.g., undernutrition or obesity) (Mungreiphy and Kapoor, 2010; Sen et al., 2013; Bharali et al., 2017; Mondal et al., 2017; Mitra et al., 2018; Tigga et al., 2018). The prevalence of undernutrition was found highest in the lower age groups (i.e., 20-25 years) but it is found higher in the higher age groups (i.e., 30-39 years and 40-49 years). This shows that as the age increases, there is an increase in the overweight and obesity among women. Similarly, the undernutrition, overweight and obesity was found highest among the women's involved in service or other income generating activities as compared to those not engaged in any work. The prevalence of undernutrition was observed to be lower than Tangkhul Naga, Manipur (16.20%) (Mungreiphy and Kapoor, 2010), Santal, West Bengal (45.1%) (Kshatriya and Acharya, 2016), Sarak, Jharkhand (45.36%) (Dutta Banik, 2011) and Savar, Orissa (49.0%) (Bose et al., 2006), but a similar magnitude of undernutrition was reported among Nyishi tribal of Arunachal Pradesh (10.50%) (Bharali et al., 2017).

Several investigations have reported the effect of socio-economic, physical activity and lifestyle factors on overweight-obesity (Subramanian et al., 2007; Mungreiphy and Kapoor, 2010; Rengma et al., 2015; Mondal et al., 2017; Sinha et al., 2018; Tigga et al., 2018; Young et al., 2019). The prevalence of undernutrition, overweight and obesity were found to be higher among women having less number of children. Illiteracy is a great cause for the poor nutritional status (e.g., undernutrition) of the women in the present investigation. Lack of proper dietary knowledge, inadequate food intake, micro-nutrient deficiencies, and require of health awareness may be attributed to health condition deteriorations of an individuals or population. The results of the present investigation showed that there is high prevalence of abortion and still-birth in the age-group of 40-49 years signifying obesity and overweight as a cause for this anomaly (e.g., Cardozo et al., 2012; Okeh et al., 2015; Beavis et al., 2015; Arnold et al., 2016). Several research investigations have shown the effects of different socio-economic and demographic factors affecting the nutritional status among adult individuals in India (Subramanian and Smith, 2006; Subramanian et al., 2007; Mungreiphy and Kapoor, 2010; Sen et al., 2013; Rengma et al., 2015; Bharali et al., 2017; Mondal et al., 2017; Tigga et al., 2018). However, the associations with socio-economic, demographic and lifestyle variables with the prevalence of undernutrition, overweight and obesity were observed to statistically not significant among Karbi tribal women ($p>0.05$) (Table 3). Furthermore, the comparison of the results of the present investigation with several other women populations in India (Ashthana et al., 2001; Mishra et al., 2001; Bhadra et al., 2005; Mungreipy and Kapoor, 2010; Dutta Banik, 2011; Mahanta et al., 2012; Kshatriya and Acharya, 2016) showed that the prevalence of undernutrition was observed to be lower (i.e., 10.66%) among tribal Karbi women. However, the prevalence of obesity (BMI$\geq$ 25.00 kg/m^2) was observed to be higher among Karbi women (34.0%) than the studies done on Indian populations of West Bengal (17.45%) (Bhadra et al., 2005), Andhra Pradesh (2.00%) (Griffith and Bently, 2001), Jammu and Kashmir (23.69%) (Zarger et al., 2000), Northern India (15.60%) (Mishra et al., 2001), Tamil Nadu (2.20%) (Thomas and Krishnaswami, 1995), Uttar Pradesh (30.24%) (Ashthana et al., 2001), Assam (11.63%) (Rengma et al., 2015) and Arunachal Pradesh (9.57%) (Bharali et al., 2017). Several socio-economic, demographic and lifestyle variables contributes significantly to the malnutrition and several health related complications in populations. Apart from this, unavailability of the basic health facilities along with lack of proper transportation facility and poor hygiene standards in many areas of this district contributes significantly to the poor health status among the women. The

results of the present investigation showed that overall prevalence of abortion and still-births among the Karbi women was observed to be 18.67% and 9.33%, respectively (Table 4). According to Hazarika and Chutia (2013), miscarriage and abortions including loss of fertility are another health issues in the North-eastern tribal populations. Several researchers have reported that obesity has adverse role to play in poor reproductive outcomes and sub-fecundity due to impaired receptivity and may lead to placental abnormalities as manifested by higher rates of miscarriage and stillbirth in women (Belliver et al., 2007; Fitzsimons et al., 2009; Broughton and Moley, 2017; Luke, 2017). The results of the present investigation showed that the frequency distribution of number of abortion (23.53%) and still birth (11.76%) were found to be higher among obese Karbi tribal women (Table 5). Several researchers have reported that poverty, and inadequacy of knowledge about health have been found to be the major determining factors of abortion and still birth occurrence leading to gradual degradation of reproductive status of women (e.g., Hazarika and Chutia, 2013; Altijani et al., 2018). Moreover, it is accepted fact that a lack of poor socio-economic status, education, knowledge and awareness could be the major concern for poor for primary prevention of malnutrition or DBM, through healthy food patterns and lifestyles modification, as well as limited access to primary healthcare services for secondary prevention and treatment could aggravate the current health situation in population.

Conclusion

Malnutrition is a serious health issue and considerable numbers of indigenous Karbi tribal women are suffering from double burden indicating both undernutrition and overnutrition (e.g., overweight-obesity). The health issues related to the poor reproductive health outcomes such includes abortion and miscarriages were also observed among rural Karbi tribal women. The results indicates the existence of DBM among Karbi women which calls for formulation of appropriate health intervention strategies to address both ends of energy balance and malnutrition spectrum and to evaluate the efficacy of ongoing healthcare programme in population.

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