

ABSTRACT

Nutritional status can assess optimum level of nutrition available to the community, which has prognostic value for related morbidity and mortality prevailing in the community. Nutritional status is helpful in promoting good health. Increasing overweight and obesity among the populations of developed and developing countries are known to cause diseases like hypertension, diabetes, cardiovascular diseases and certain types of cancer. The situation becomes worst in developing countries like India due to the persisting problem of undernutrition. Such simultaneous existence of undernutrition and overnutrition is a challenge to the policy maker and researchers. Obesity has even penetrated the traditional societies of India. This is intergenerational in nature which starts before conception and pickup during infancy and continues for generations. The alternation between underweight and obesity in a life cycle will soon become common in developing countries due to the exposure to an obesogenic environment and persisting undernutrition. In this background, understanding the prevalence of undernutrition, overweight, and obesity and its determinants is important and provides a stepping stone for further investigation and intervention. The present study is probably the first of its kind conducted among any homogenous population of Sikkim and will provide the basic data on the nutritional status and associated factors.

The objectives of the present study are as follows:

- To assess nutritional status and body fat distribution using anthropometric measurements and derived indices using internationally accepted cut-off points.

- To document associations of different socio-economic variables with nutritional status and body fat distribution.
- To assess age and sex related changes in nutritional status and body fat distribution.
- To compare findings of the present study with other available international and national data.

The present cross-sectional study was conducted among 992 adult Limboo individuals (males: 496; females: 496) aged between 18-64 years of age. The study location was villages of West Sikkim namely, Langang, Tikjek, Linghom, Darap, Singpheng, and Nambu. The individuals were selected using a multistage sampling method. Through this process, 15 villages were listed and then it was reduced to 6 villages depending on distances from the main urban centre of Gyalshing. The villages were selected based on the predominance of Limboo individuals. The data was collected during the period from January 2014 to April 2016 from above-mentioned 6 villages.

The demographic, socio-economic, and lifestyle variables such as sex, age, marital status, education, occupation, monthly income, SES, family size, land holding, house type, drinking water and toilets facility were collected to assess their influences on the nutritional status and the diseases outcomes. Anthropometric measurements such as height, weight, arm span, arm length and mid-upper arm circumference (MUAC), waist circumference (WC), hip circumference (HC), neck circumference (NC) and the skinfolds (BSF, TSF, SSF and SISF) were recorded following standard procedures (Weiner and Lourie, 1981; WHO, 2008; Ben-Noun et al. 2001). Various indices of nutritional status and body composition were derived from the

anthropometric measurements were utilised to assess nutritional status exclusively and in combinations. The statistical analyses such as mean \pm SD, ANOVA, χ^2 , correlation, regression, logistic regression, ROC-AUC were conducted using SPSS 20.

The observed anthropometric measurements such as height, weight, arm span, RAL, LAL, MUAC, NC, SH were significantly high among the male Limboo individuals and adiposity measures like WC, HC, TSF, BSF, SSF, and SISF were high among female Limboo individuals. Similarly, anthropometric indices like CRI, TUA, UMA, BFMA, FFM, and FFMI were observed high among male Limboo individuals and indices of body adiposity such as BMI, BAI, WHtR, WHR, CI, UFA, AFI, PBF, FM, and FMI were observed significantly high among female Limboo individuals. Age related changes were observed in the anthropometric measurements of the male and female Limboo individuals excluding arm span and arm length. Similarly, influence of age was observed in all the anthropometric indices in the present study excluding on CRI among males.

The overall prevalence of undernutrition was 7.56% and 10.18% among Limboo individuals assessed using BMI and MUAC, respectively. The sex specific undernutrition based on BMI among males and females was 6.85% and 8.27%, respectively. The prevalence according to MUAC was 6.45% and 13.91%, respectively among males and females. The sex specific prevalence of overweight using traditional BMI classification was 18.35% and 24.4% for males and females, respectively. Similarly, obesity observed was 2.23% and 5.85% among male and female individuals, respectively. The sex difference in the prevalence of overweight and obesity was significant ($p < 0.05$). Using Asia-Pacific classifications, the observed overweight was equal among (17.14%) both sexes, and obese I (24.40%

vs.18.75%) and obese II (5.85% vs. 2.02%) were significantly ($p<0.05$) high among female than male individuals.

The prevalence of central obesity given by WC (male: 10.89%; female: 59.07%), WHtR (male: 48.79%; female: 82.26%), WHR (male: 98.99%; female: 95.36%), and CI (male: 43.55%; female: 91.94%) were higher than the prevalence given by traditional BMI classification and Asia-Pacific classification. The male Limboo individuals were significantly at high risk by WHR and female Limboo individuals were significantly at high risk by WC, WHtR, and CI. The prevalence of obesity related risk simultaneously identified by BMI and one of the central obesity indices such as WC (male: 42.94%; female 10.89%), WHtR(male: 34.88%; female 46.77%), WHR (male: 37.90%; female: 46.77%), and CI (male: 21.17%; female: 45.16%) is worth concern for health policy and planning. Prevalence of normal weight central obesity by different combination like WC and BMI (male: 16.13%; female: 0%), WHtR and BMI (male: 13.91%; female: 35.48%), WHR and BMI (male: 61.09%; female: 48.59%), and CI and BMI (male: 22.38%; female: 46.77%) was alarming given its association with CVDs.

However, the prevalence of elevated adiposity assessed using PBF and FMI ranged from 1% to 7.96%, which is less than the prevalence given by various BMI and central adiposity indices. In spite of relatively low adiposity given by PBF and FMI, the absence of normal individuals based on FFMI with a large number of Individuals falling under the low FFMI category can cause sarcopenia, thereby leading to NCDs.

Undernutrition assessed by BMI was less likely to associate with any of the factors taken in the study. The overweight and obesity based on BMI were observed

to be influenced by factors like sex, occupation, age, marital status, family monthly income, and SES. The central obesity assessed by WC and WHtR was associated with sex, age, marital status, occupation, family monthly income.

The present study population is at risk of adiposity related mortality and morbidity. The prevalence of adiposity was higher in the Limboo individuals of the present study compared to the rural and tribal populations of India.