

Chapter 5

SUMMARY AND CONCLUSION

The present study was conducted among the Limboo individuals of West Sikkim. The study was design to assess the nutritional status using anthropometry and body composition. Further, study analysed the association of demographic, socio-economic and life style factors with nutritional status among the Limboo individuals of Sikkim. The participants of the study were the residents of villages of West Sikkim, selected through multistage sampling method. The studied individuals were adults with mean age of 34.73 years \pm 12.47. Adults of this age form working section of a population who are responsible for their family economic needs and welfare. The well being of such adult individuals is important as they are responsible for fulfilling the economic needs of other family members in a country like India. The assessment of nutritional status in a homogenous population of Sikkim was never conducted before as per the literature search using *Pubmed*. The prevalence of underweight was assessed utilizing BMI and MUAC. The prevalence of obesity was assessed utilizing BMI classification of WHO (1995) and WHO (2000). Central obesity was assessed using WC, WHtR, WHR, and CI. The distribution of adipose tissue was assessed using skinfolds measurements in addition to above mention indices. To find out the associated demographic, socio-economic and life style factors with underweight, overweight, and obesity, multinomial logistic regression was conducted. The prevalence of both underweight and obesity were also assessed using combination of above mention indices. The comparative discussion of the findings of the present study with the available Indian and non-Indian studies were accomplished.

5.1 SUMMARY FINDINGS

- The anthropometric and body composition measures like height, weight, armspan, RAL, LAL, MUAC, NC, SH were significantly high among the male Limboo individuals compared to female Limboo individuals. Interestingly, the measures of body adiposity such as WC, HC, TSF, BSF, SSF, and SISF were significantly high among female Limboo individuals compared to male Limboo individuals.
- Similarly, indices like CRI, TUA, UMA, BFMA, FFM, and FFMI were observed higher among male Limboo individuals and indices of body adiposity were observed high among female Limboo individuals. The adiposity indices were BMI, BAI, WHtR, WHR, CI, UFA, AFI, PBF, FM, and FMI.
- There was no consistency in the sexual dimorphism observed in the adiposity indices among different populations cited in the present study, which could be the result of increasing obesity among those populations.
- The height, SH and TSF among male Limboo individuals and height, SH, TSF, BSF and SISF among female Limboo individuals were observed declining in 50-64 years. Increase in NC, WC, and HC during 30-49 years age was observed irrespective of sex.
- The measurements like MUAC, BSF, SSF, and SISF among males and weight, MUAC, and SSF among females were high in the 30-49 years age group.
- The derived indices increasing during 30-49 years age among both male and female Limboo individuals were BMI, BAI, WHtR, WHR,

CI, FFM, and FFMI. Only among females declined in BMI was observed during 50-64 year of age.

- The indices like TUA, UMA, BFMA, FM, and FMI was observed changing across age groups of irrespective of sex with peak in the 30-49 years age group and then decline.
- The declined in PBF and UFA was observed irrespective of sex during 50-64 years of age. However, increase during 30-49 years of age was only evident among males.
- The mean height of the Limboo adults of the present study reveals relatively stressful environment during childhood which has implication in the prevalence of high obesity and related diseases. However, many other Indian population heights were observed below the mean height of the Limboo individuals of the present study which suggest diseases environment during childhood among these populations of India.
- The mean BMI reported from south India and urban populations of India were higher than the mean BMI observed in the present study. The reported mean BMI of rural and tribal populations of India were lower than the present study.
- The observed central obesity mean values of the present study were well above the reported mean values of different populations of rural and tribal region of India. A population of Northeast India was reported with cardiometabolic risks even in lower mean values of BMI, WC, WHR, and WHtR than the Limboo individuals of the present study.

- Studies reported from India including the present study observed increased truncal fat deposition using skinfolds, which could be function of increasing adiposity and life style modification.
- The comparison of mean PBF of different Indian populations with the Limboo adults of the present study has shown relatively high adiposity among other populations. This condition specifically among tribal and rural population was alarming, which may lead to sarcopenia as most of these population were undernourished until recently.
- The prevalence of undernutrition observed among the Limboo individuals of the present study was 7.56% according to BMI and 10.18% according to MUAC. The sex specific undernutrition among men and women was 6.85% and 8.27%, respectively as per BMI. The prevalence based on MUAC was 6.45% and 13.91%, respectively among men and women in the present study. The prevalence rate observed was lower compared to tribal and non-tribal populations of India. However, low prevalence does not mean absence of undernutrition. Infact WHO has considered such rate of prevalence of undernutrition as warning sign and worth a concern.
- The prevalence of overweight and obesity was observed 21.37% and 4.03%, respectively among the Limboo individuals of the present study. The sex specific overweight was 18.35% for male and 24.4% for female. Similarly, obesity observed was 2.23% and 5.85% among male and female individuals of the present study, respectively. These results were obtained using traditional classification of BMI (WHO 1995).

The sex difference in the prevalence was significant ($p < 0.05$) both in overweight and obesity.

- The prevalence increased when Asia-Pacific classification was used. The corresponding prevalence of Overweight, Obese I and Obese II according to Asia-Pacific BMI classification was 17.14%, 21.57% and 3.93% in the present study Limboo population. 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 Limboo individuals.
- The age group 30-49 years was observed with high prevalence of overweight and obesity using traditional BMI classification (WHO, 1995) and Asia-Pacific classification (2000), The Limboo female individuals were affected in most of the age groups except in case of overweight given by Asia-Pacific classification where men were more overweight.
- The prevalence of overweight and obesity was higher compared to the prevalence observed among other population of Northeast, India and closer to the prevalence observed among city dwelling populations of India.
- The central obesity indices have given higher prevalence than the prevalence given by traditional BMI criteria (25.20%) and Asia-Pacific criteria (42.64%). The prevalence of central obesity observed using WC, WHtR, WHR and CI was 34.98%, 65.52%, 97.18%, and 67.54%, respectively. The male Limboo individuals were observed highly at risk given by WHR and female individuals at high risk according to

WC, WHtR, WHR, and CI. The sex difference in the prevalence of central obesity was highly significant ($p < 0.001$) among the Limboo individuals.

- The prevalence of obesity given by combination of BMI with WC, BMI with WHtR, BMI with WHR, and BMI with CI among Limboo male individuals was 42.94%, 34.88%, 37.90%, and 21.17%, respectively. The respective prevalence obtained for Limboo female individuals was 10.89%, 46.77%, 46.77%, and 45.16%.
- The normal weight centrally obese individual is normal weight by BMI and obese by central obesity indices like WC, WHtR, WHR, and CI. Such combinations each of central obesity indices with BMI have observed normal weight central obesity prevalence of 16.13% (WC and BMI), 13.91% (WHtR and BMI), 61.09% (WHR and BMI), and 22.38% (CI and BMI) among male Limboo individuals. The corresponding prevalence among Limboo female individuals was 0%, 35.48%, 48.59%, and 46.77%. Among the male and female Limboo individuals the highest prevalence of normal weight central obesity was given by combination of WHR with BMI.
- The over fat individuals were less (1.00-7.96%) in the present study as identified using Niemen (1995), Muth (2009), and commonly used cut-offs of 25% for men and 30% for women. The relatively low PBF in the present study population was observed compared to available studies on Indian and Non-Indian populations.
- The normal weight obesity using BMI and PBF was nearly absent (0.20%) in the present study however, the individuals with Overweight

(male: 0; female: 0.60%), Obese I (male: 0.60%; female: 5.85%) and Obese II (male: 0.60%; female: 4.84%) was found with elevated PBF. Females were mostly at risk in the present study.

- The prevalence of high FMI was 7.96% which was higher than the observed elevated PBF using different criteria in the present study. However, only low FFMI was observed among the studied male individuals and normal FFMI was absent as per the criteria used.
- Limboo individuals of age group 30-49 years were less likely to get underweight in the present study.
- The individuals falling under manual occupation, 30-49 years age group, married individuals, UM SES, LM SES, family monthly income > ₹ 10,000 and females were more likely to be overweight. Similarly obesity was observed with non-manual occupation, 30-49 years age group, 50-64 years age group, upper middle SES and female individuals.
- Central obesity observed using WC was likely to be among individuals of female sex, middle age, old age, married, non-manual, manual, upper middle SES, and family monthly income > ₹ 10000. This also applies to WHtR excluding family monthly income which was not influencing WHtR in either direction.

5.2 LIMITATIONS

- There could be other factors not considered by the present study influencing prevalence of underweight, overweight, obesity and central obesity among Limboo population in the present study.

- The rising overweight and obesity among the various populations is considered as results of changing diets, dietary behaviours, and physical activity. However, these aspects of nutritional assessment were not included in the present study. Further studies with inclusion of such dietary assessment and physical activity level may provide clear picture of factors behind such escalated obesity.
- The use of available cut-offs of PBF may not be adequate because until now there is no cut-offs for PBF recommended by WHO.

5.3 RECOMMENDATIONS

- a. Health worker should be trained to understand the different level of obesity and associated risk.
- b. The health centre and clinics should introduce use of simple anthropometric indices like BMI and WC, which will be effective in the mitigation NCDs related to obesity.
- c. Escalated normal weight central obesity and overall central obesity need immediate attention.
- d. Individuals should be educated about importance of diet and physical activity in promoting health and well being.
- e. Population based survey on prevalence of NCDs along with data on diet, physical activity, and nutritional status is the need of the hour.
- f. The hidden hunger and food insecurity should be understand well and address with proper planning.
- g. Planning of urban area should consider the space to promote physical activity.
- h. The present study has given cut-offs for NC and BAI which are relatively new measures of adiposity.

- i. Further, studies on nutritional assessment should be conducted among children and elderly.

5.4 CONCLUSION

The prevalence of undernutrition in the present study compared to other populations of India was low. The undernutrition is declining in Sikkim. However, the prevalence observed in the present study was higher than the reported prevalence of NFHS-3 and NFHS-4 for Sikkim. Further, a step towards reduction of undernutrition is important because it is still a warning sign. Overweight and obesity observed in the present study was relatively higher than the reported prevalence of rural and tribal population of India. Obesity predisposed individuals and populations to various NCDs like diabetes, cancer, cardiovascular diseases, etc. Overweight and obesity in the present study was assessed using BMI classification of WHO (1995) and WHO (2000). The BMI classification for Asia-Pacific region (WHO 2000) was put forth because Asians were predisposed to MetS and diseases at lower BMI compared to their European counterparts. This phenomenon is well established among Indian populations. The present study too observed high prevalence of overweight and obesity among Limboo individuals using Asia-Pacific BMI classification (WHO 2000). Susceptibility to NCDs at lower BMI among Indian compared to their European counterparts and high PBF among Indian compared to European counterparts with same BMI was explained by high prevalence of central obesity among Indians. The Limboo individuals of Sikkim studied in the present study was observed with high prevalence of central obesity. The central obesity was 2-3 folds higher compared to obesity given by BMI. The female Limboo individuals were more at risk of central obesity related diseases than male Limboo individuals. The high prevalence was observed among female and middle age individuals. There was high

prevalence of normal weight centrally obese individuals who are normal by BMI alone and defined obese by any one central obesity indices like WC, WHtR, WHR and CI. Studies have shown such individuals at high risk of MetS and cardiovascular dysregulation. Interestingly, normal weight obesity define using BMI and PBF was not observed in the present study, which indicates diseases risk among the studied population may be due to visceral fat deposition not total fat. Further, the Limboo population were observed with lower prevalence of elevated PBF by different criteria used in the present study. The condition like sarcopenia was observed among different Indian population, owing to prevalent undernutrition and reported high PBF. The present study speculate propensity to sarcopenia because of low FFMI and not because of high PBF among the Limboo individuals of the present study. The body composition component like FMI was observed high and FFMI was observed mostly low using criteria given by Khongsdier (2005). The sarcopenia can be suspected among the studied population based high FMI and absent of normal FFMI, which needs further investigation. This is the high time for stack holders to take necessary steps for prevention of obesity related death and disability.