Chapter 3

RESULTS

3.1 DISTRIBUTION OF DEMOGRAPHIC, SOCIO-ECONOMIC, AND LIFE STYLE RELATED VARIABLES AMONG THE LIMBOO INDIVIDUALS

3.1.1 POPULATION SIZE AND STRUCTURE

The present study comprised of 992 adult Limboo individuals, of which 496 were males and 496 were females. The selected age group was 18 – 64 years with mean age of 34.73 years (±12.37). The individuals in the present study were further categorised into three categories such as 18 – 29 years, 30 – 49 years and 50 – 64 years. Each of the age groups comprised of 405 (40.83%), 421 (42.44%), 166 (16.73%) adult Limboo individuals of both sexes (Figure 3.1). In the first age group males and females was 46.67% and 53.33%, respectively. It was 51.31% males and 48.69% females in the second age group. Further the last age group have 54.82% males and 45.18% females. The χ^2 test between sex was not significant in the age categories (χ^2 – value 3.63; d.f.2; p>0.05). The sex-specific distribution is presented in Figure 3.2.

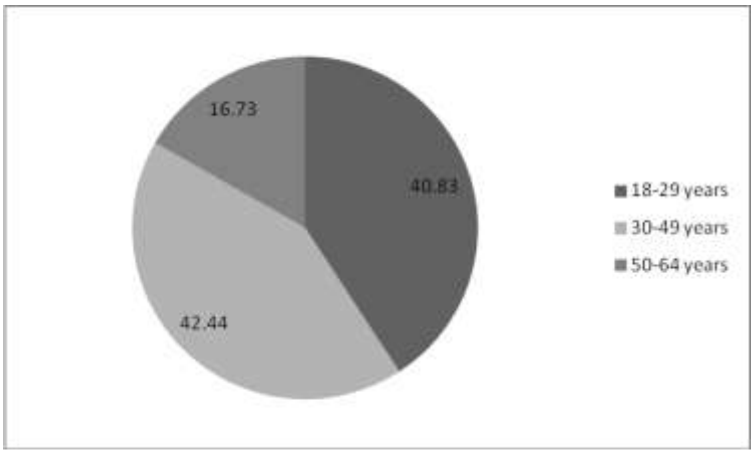


Figure 3.1: Age distribution of the Limboo individuals.

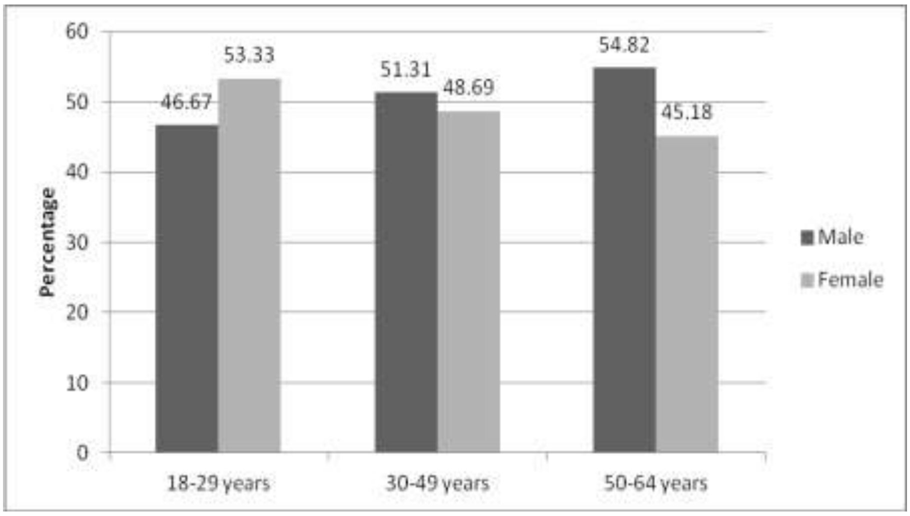


Figure 3.2: Age and sex distribution of the Limboo individuals.

3.1.2 MARITAL STATUS

As depicted in Figure 3.3 there were 75.10% married and 24.90% unmarried Limboo individuals. Unmarried males were 54.66% and females were 45.34%. The remaining 48.46% males and 51.54% females were married. The χ^2 test on marital status for sex difference yields non-significant result (χ^2 – value 2.85; d.f.1; p>0.05). The sex specific distribution is presented in Figure 3.4.

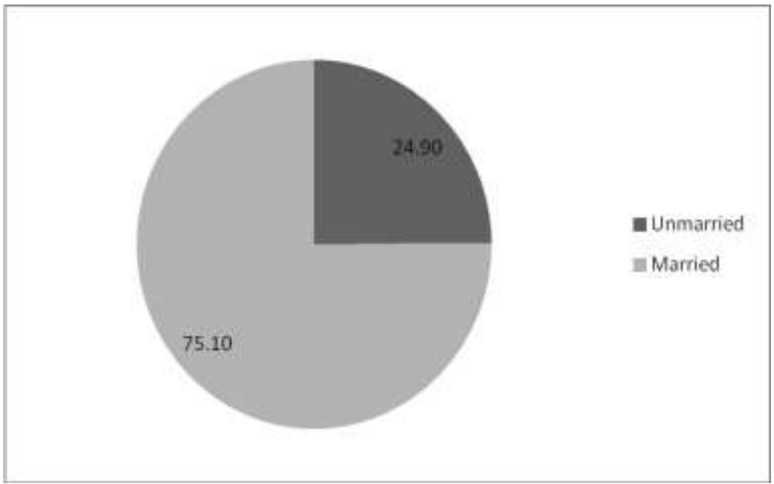


Figure 3.3: Distribution of marital status of the Limboo individuals.

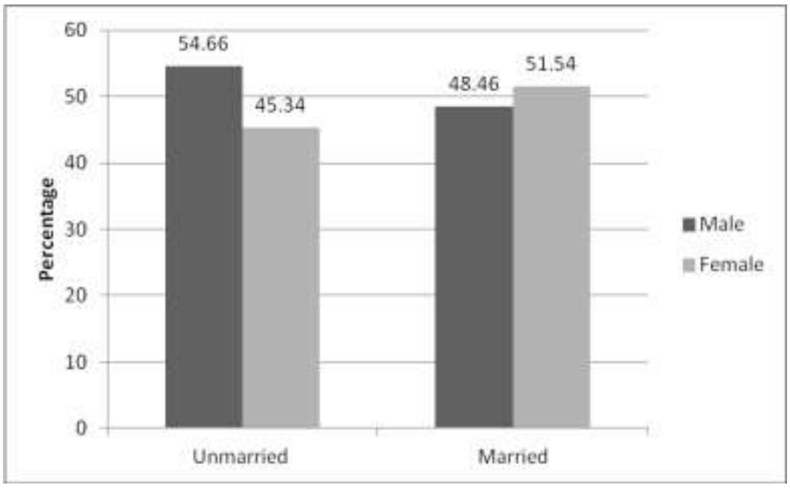


Figure 3.4: Sex specific marital status of the Limboo individuals.

3.1.3 EDUCATION

The educational attainment of the Limboo individuals irrespective of sex is presented in Figure 3.5. The categorization are illiterate, upto 8th grade and above 9th grade which consists of 245 (24.70%), 387 (39.01%) and 360 (36.29%) individuals respectively. The sex difference in these categories of educational attainment were significant (χ^2 – value 61.61; d.f.1; p<0.001). Among the individuals who never went to school, males were 28.57% and females were 71.43%. Those who studied only up to 8th grade were 59.43% males and 40.57% females. Finally educational category of above 9th grade consists of 54.44% males and 45.56% females. The sex specific distribution is presented in Figure 3.6. Along with senior secondary education the above 9th grade category consists of diploma, graduation and post graduation degree holders.

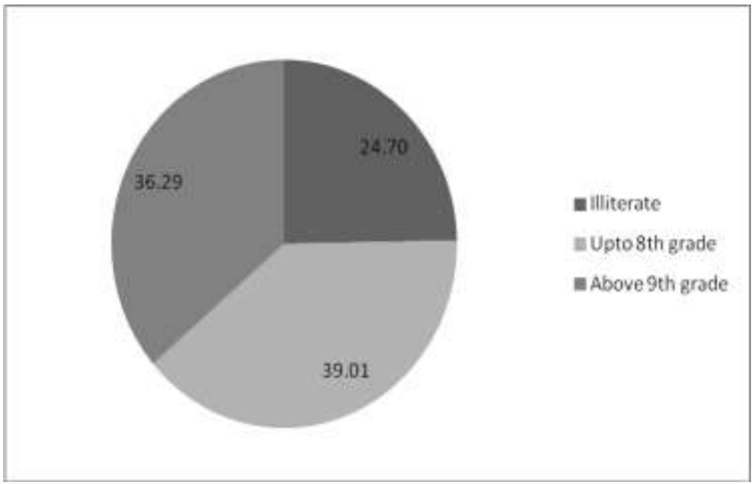


Figure 3.5: Distribution of educational attainment of the Limboo individuals.

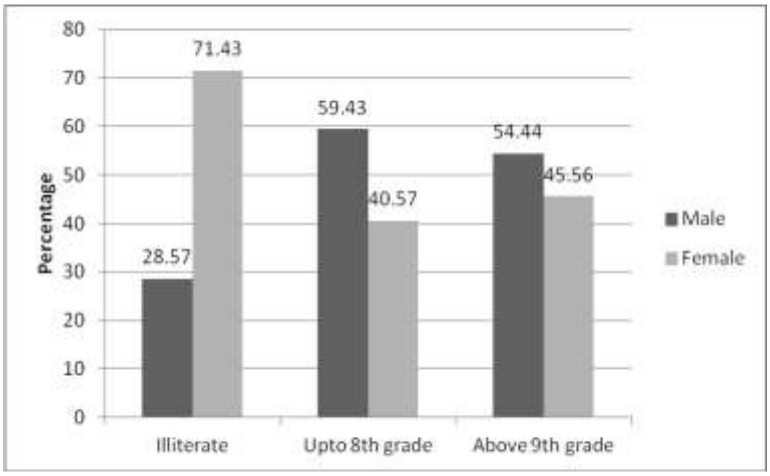


Figure 3.6: Sex specific educational status of the Limboo individuals.

3.1.4 OCCUPATION

There were total 71.77% of individuals involved in occupations which demands manual labour, among them 46.49% and 53.51% were males and females respectively. On the other hand individuals dependent on non-manual occupations were 15.83%, of which males were 66.24% and females were 33.76%. The category termed "others" has 123(12.40%) individuals of the total sample population, which comprised of 49.59% and 50.41%, males and females respectively. The overall and sex specific distribution is given in Figure 3.7 and 3.8, respectively. The χ^2 test for sex difference was significant (χ^2 – value - 63.79; d.f.5; P<0.001).

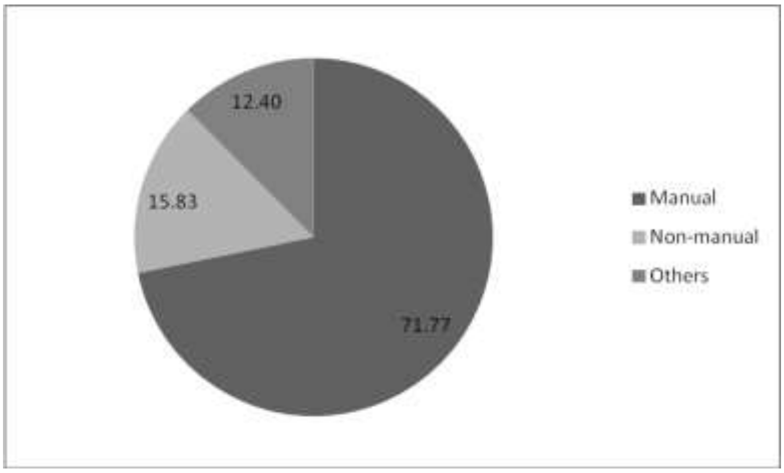


Figure 3.7: Distribution of occupation of the Limboo individuals.

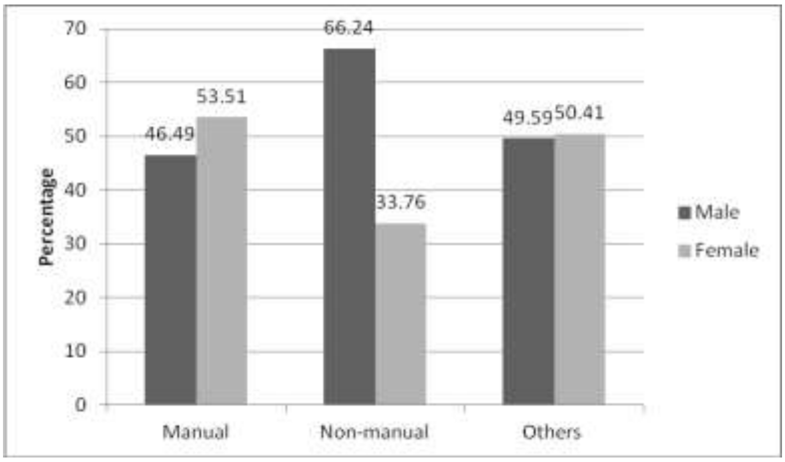


Figure 3.8: Sex specific occupations of the Limboo individuals.

3.1.5 FAMILY MONTHLY INCOME

The family monthly income of the present study population range from ₹500/= – ₹80,000/=. As shown in Figure 3.9 the individuals belonging to lower income group with family monthly income of ₹4999/= and below constitute 11.49% of the study population. The middle income group with family monthly income of ₹5000/= – ₹9999/= were 38.0% and then individuals of high income group with family monthly income above ₹10000/= were 50.50% of the total sample. Sex specific distribution of the income group is depicted in Figure 3.10. In the lower income group (≤ ₹4999/=) males and females constitute 50.88% and 49.12% respectively. In the middle income group (₹5000/= – ₹9999/=) males and females constitute 48.01% and 51.99%, respectively. The high income group (₹10000/= and above) was comprised of 51.30% males and 48.70% females. The χ^2 test between sexes and income groups (χ^2 – value 0.96; d.f.2; p>0.05) was not significant.

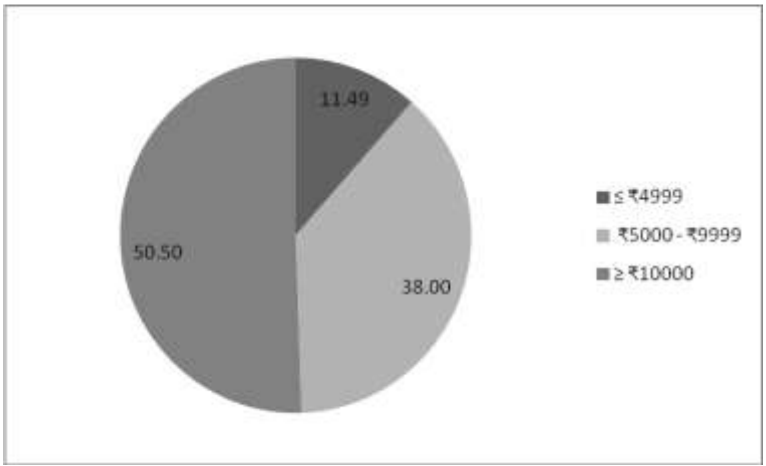


Figure 3.9: Distribution of monthly family income of the Limboo individuals.

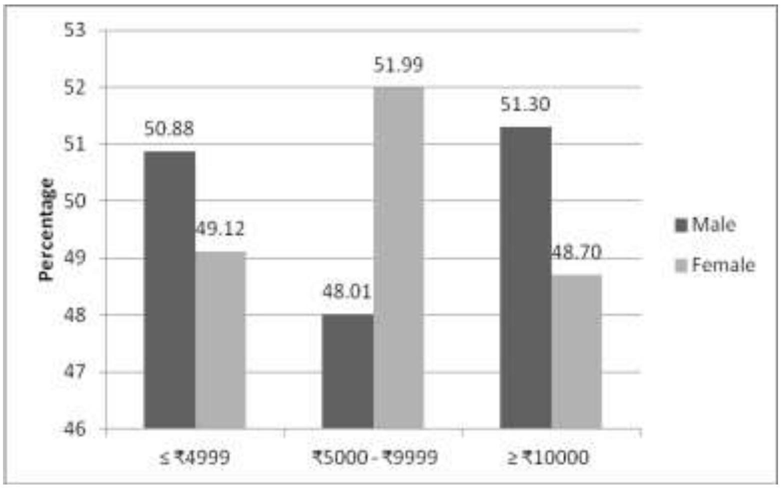


Figure 3.10: Sex specific family monthly income among the Limboo individuals.

3.1.6 SOCIO-ECONOMIC STATUS (SES)

The Kuppuswamy socio-economic status scale indentified only three socio-economic statuses among the Limboos of present study. These are Upper Middle (UM), Lower Middle (LM) and Upper Lower (UL). The overall distribution is presented in Figure 3.11. The highest number of individuals were under the UL (52.32%) which was followed by LM (30.44%) and then UM (17.24%). The sex specific pattern is given in Figure 3.12 and Table 3.1. The UM group consists of 47.95% and 52.05%, males and females, respectively. The LM group consists of 46.36% males and 53.64% females. The UL group consists of 47.21% males and 52.79% females. The sex difference between the above SES categories was not significant (χ^2 – value 3.51; d.f.1; p>0.05).

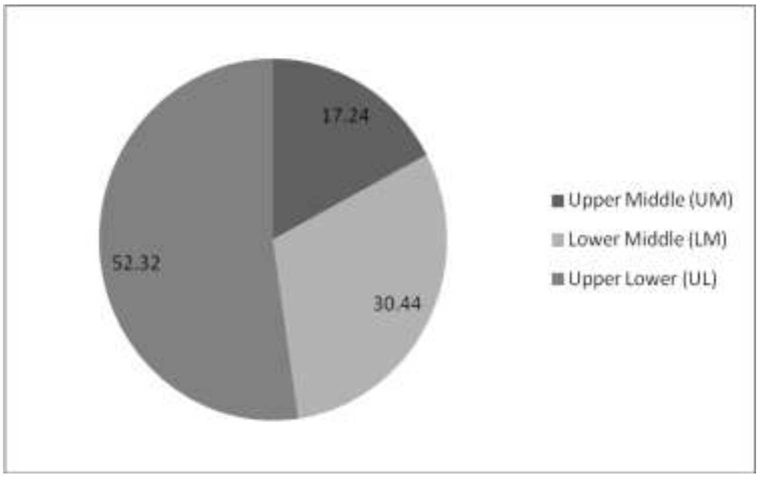


Figure 3.11: Distribution of Socio-economic status (SES) of the Limboo individuals.

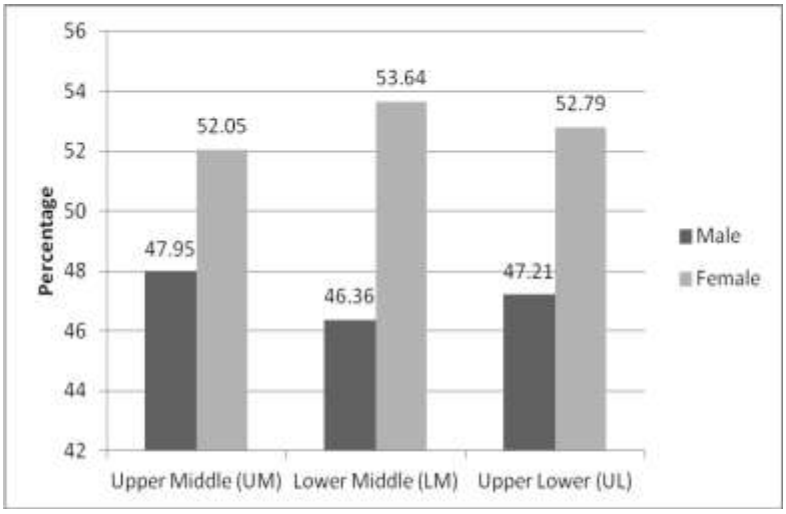


Figure 3.12: Sex specific SES of the Limboo individuals.

3.1.7 FAMILY SIZE

The distribution of small (1-4members) and large (5 and above members) family is shown in Figure 3.13. The individuals coming from small family were 333 (33.57%) and large family were 659 (66.43%). The individuals of small family consist of 50.15% males and 49.85% females (Figure 3.14). On the other hand, large family consists of 49.92% males and 50.08% females (Figure 3.14). The sex difference between above family sizes was non-significant (χ^2 – value 0.01; d.f.1; $p>0.05$).

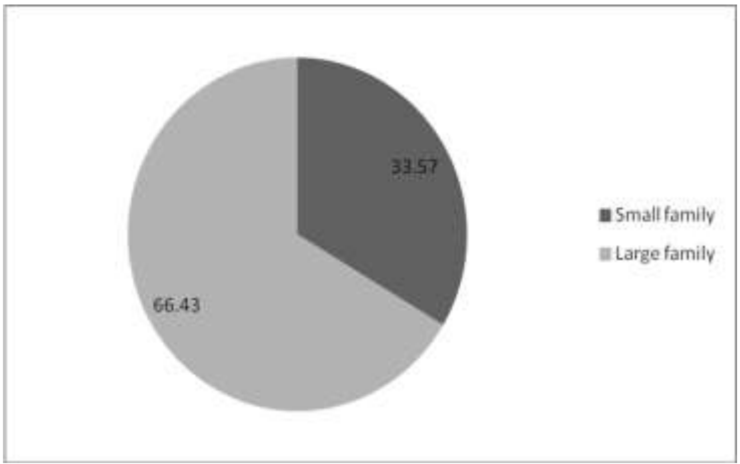


Figure 3.13: Distribution family size of the Limboo individuals.

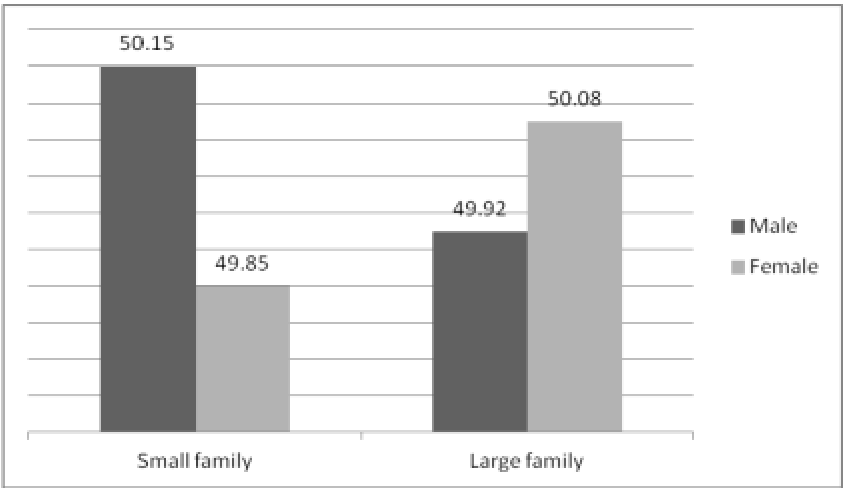


Figure 3.14: Sex specific family size of the Limboo individuals.

3.1.8 LAND HOLDING PATTERN

The two categories of land holding pattern considered in the present study were 0 – 0.99 acres and above 1 acre (≥ 1 acre). The first category consists of landless people, people with the only house and people with land below 0.99 acres and the second category consists of people with land ≥ 1 acre. The percentages of individuals with landholding 0 – 0.99 acres and ≥ 1 acre were 32.86% and 67.14%, respectively (Figure 3.15).

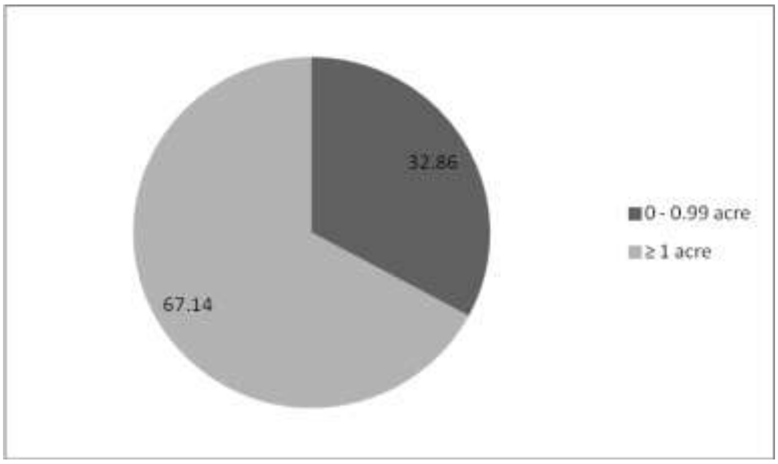


Figure 3.15: Distribution of land holding pattern of the Limboo individuals.

The sex specific distribution of the land holding pattern is shown in Figure 3.16. About 53.60% and 46.40%, males and females, respectively have land holding of 1 acre and above. On the other hand, 42.64% and 57.36%, male and female individuals were observed in the category with land holding 0 – 0.99 acres, respectively. The χ^2 test result was significant for the sex difference in land holding pattern (χ^2 – value - 10.53; d.f.1; $p<0.05$).

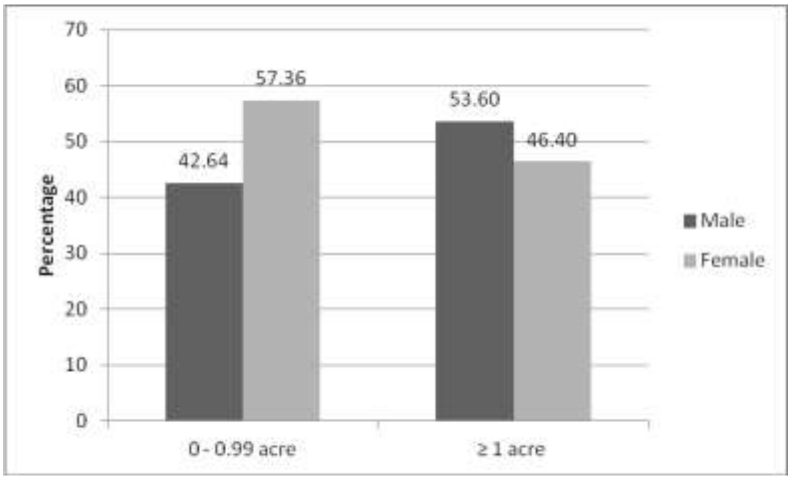


Figure 3.16: Sex specific land holding pattern of the Limboo individuals.

3.1.9 HOUSE TYPE

The pie diagram (Figure 3.17) shows the distribution of house type among the Limboo individuals of the present study. The majority houses were "pakka" (55.14%) followed by "kacha" (26.41%) and "semi-pakka" (18.45%). The sex specific distribution is given in Figure 3.18. Among the individuals staying in pakka house 50.09% were females and 49.91% were males. Among the kacha house dwellers 52.67% were males and 47.33% were females. The semi-pakka house dwellers comprised of 46.45% males and 53.55% females. The χ^2 test yield non-significant result (χ^2 – value 1.67; d.f. 2; $p>0.05$).

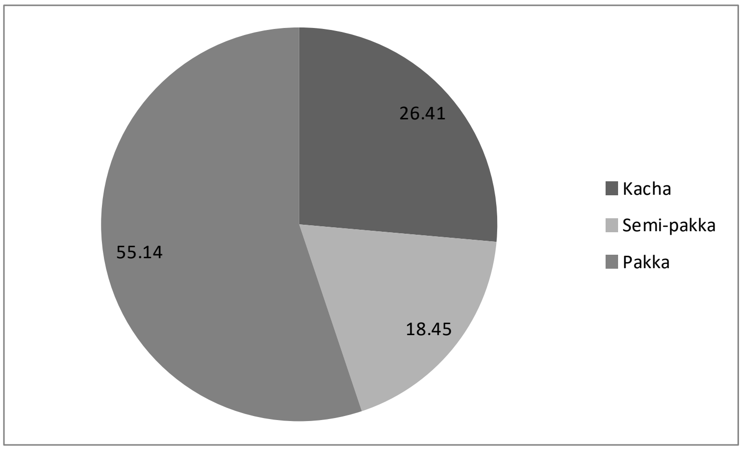


Figure 3.17: Distribution of house type of the Limboo individuals.

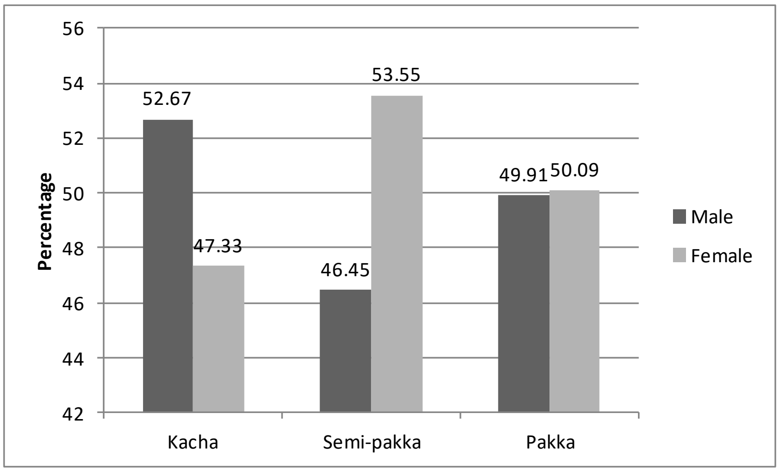


Figure 3.18: Sex specific house type of the Limboo individuals.

3.1.10 DRINKING WATER

There were mainly two type of drinking water source in Sikkim, one is government supply as a part of its welfare system and the other is piped from spring and nearby natural sources of water by people with their own effort. For this the terms supply and piped has been used respectively in the present study. Total numbers of individuals from households with the piped source of drinking water were 58.37% and those with supply source of drinking water were 41.63%. The distribution is depicted in Figure 3.19. Among the individuals with piped source of drinking water facility 46.25% were males and 53.75% were females. Similarly, among the individuals of household with supply source of drinking water 52.68% were males and 47.32% were females. The sex specific distribution is presented in Figure 3.20. The sex difference between the sources of drinking water was significant (χ^2 – value - 3.98; d.f.1; $p<0.05$).

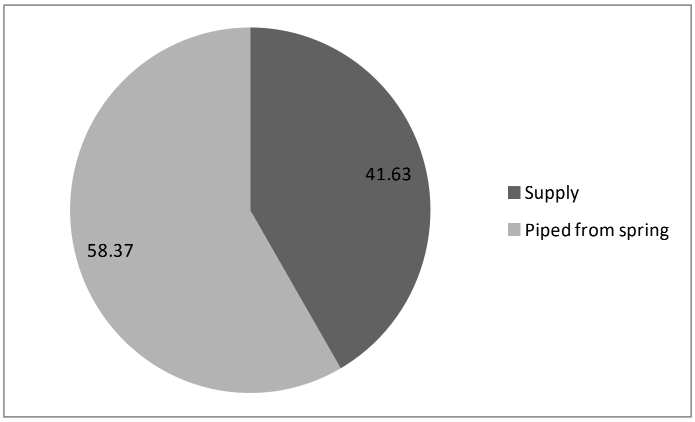


Figure 3.19: Distribution of available drinking water source of the Limboo individuals.

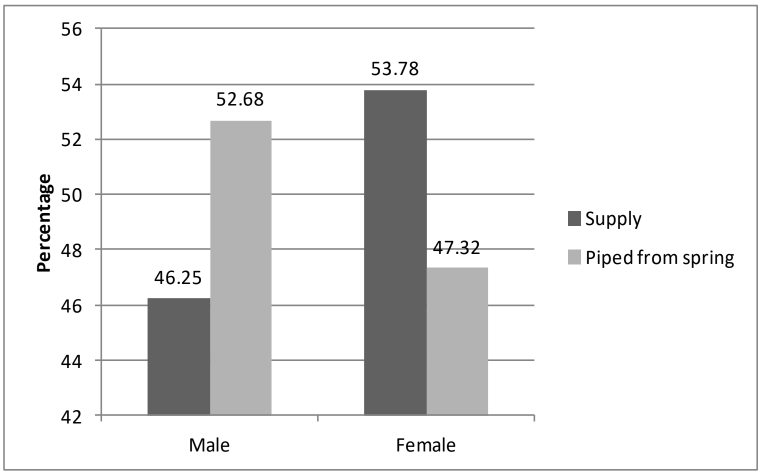


Figure 3.20: Sex specific source of drinking water of the Limboo individuals.

3.1.11 TOILET

In the present study no households were found without toilet. The two types of toilets differ in structure only not on hygienic condition with few exceptions. Overall 858 (86.49%) individuals belonged to households with commode toilet and remaining

134 (13.51%) individuals were from the households with pit toilet (Figure 3.21). The individuals from the commode toilet households consist of 50.35% males and 49.65 % females. Further 47.76% were males and 52.24% were females from the households with pit toilet. The sex difference was not significant for the individuals of households with commode and pit toilets (χ^2 – value 0.31; d.f.1; p>0.05). The sex specific distribution was presented in Figure 3.22.

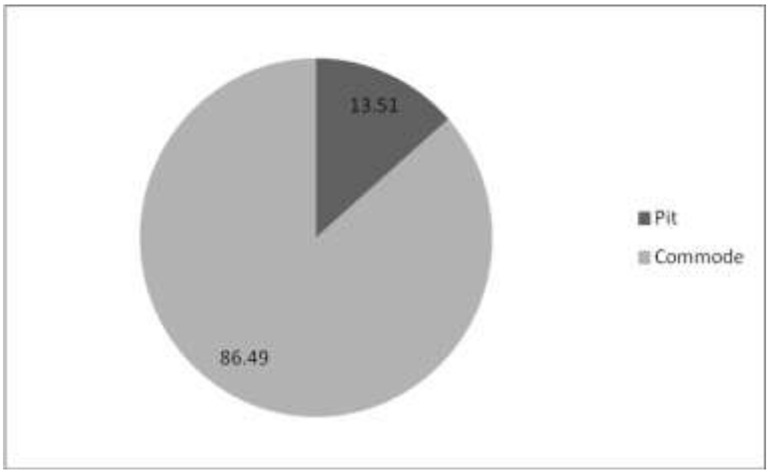


Figure 3.21: Distribution of types of toilet of the Limboo individuals.

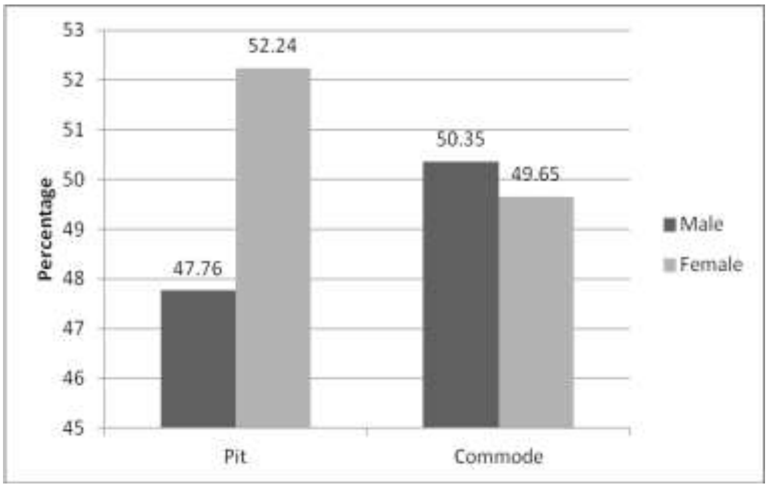


Figure 3.22: Sex specific break-ups of types of toilet of the Limboo individuals.

Table 3.1: The sex wise distribution of socio-economic, demographic, and life style variables of the Limboo individuals

Variables	Categories	Male	Female	χ^2-value
Age group	18-29 years	189 (46.67)	216 (53.33)	3.63; d.f.2; p>0.05
	30-49 years	216 (51.31)	205 (48.69)	
	50-64 years	91 (54.82)	75 (45.18)	
Marital status	Unmarried	135 (54.66)	112 (45.34)	2.85; d.f.1; p>0.05
	Married	361 (48.46)	384 (51.54)	
Education	Illiterate	70 (28.57)	175 (71.43)	61.61; d.f. 2; P<0.001
	Upto 8th grade	230 (59.43)	157 (40.57)	
	≥ 9th grade	196 (54.44)	164 (45.56)	
Occupation	Manual	331 (46.49)	381(53.51)	20.09; d.f. 2 p<0.001
	Non-manual	104 (66.24)	53 (33.76)	
	Others	61 (49.59)	62 (50.41)	
Income	≤ ₹4999	58 (50.88)	56 (49.12)	0.96; d.f.2; p>0.05
	₹5000 – ₹9999	181 (48.01)	196 (51.99)	
	≥ ₹10000	257 (51.30)	244 (48.70)	
SES	Upper Middle (UM)	82 (47.95)	89 (52.05)	3.51; d.f.1; p>0.05
	Lower Middle (LM)	140 (46.36)	162 (53.64)	
	Upper Lower (UL)	245 (47.21)	274 (52.79)	
Family size	Small	167 (50.15)	166 (49.85)	0.01; d.f.1; p>0.05
	Large	329 (49.92)	330 (50.08)	
Land holding	0 – 0.99 acre	139 (42.64)	187 (57.36)	10.53; d.f. 1; p<0.05
	≥ 1 acre	357 (53.60)	309 (46.40)	
House type	Kacha	138 (52.67)	124 (47.33)	1.67;d.f. 2; p>0.05
	Semi-pakka	85 (46.45)	98 (53.55)	
	Pakka	273 (49.91)	274 (50.09)	
Drinking Water	Supply	191 (46.25)	222 (53.75)	3.98; d.f.1; p<0.05
	Piped from spring	305 (52.68)	274 (47.32)	
Toilet	Pit	64 (47.76)	70 (52.24)	0.31;d.f.1; p>0.05
	Commode	432 (50.35)	426 (49.65)	

Figures in the parentheses are percentage

3.2 ASSESSMENT OF NUTRITIONAL STATUS USING ANTHROPOMETRY AND BODY COMPOSITIONS CHARACTERISTICS

3.2.1 GENERAL DESCRIPTIVE STATISTICS OF AGE AND ANTHROPOMETRIC VARIABLES

The sex specific and overall mean and SD of the studied anthropometric variables and age are given in Table 3.2. The overall (n = 992) mean age of the study population was 34.73 years (±12.47) with range of 18 to 64. The age of male individuals ranged from 18-64 with mean (SD) of 35.71 years (±12.78) and the mean age of females ranged from 18-63 with mean (SD) of 33.74 years (±12.09). The anthropometric measurements taken in the present study were height, weight, arm span, RAL, LAL, MUAC, NC, SH, WC, HC, TSF, BSF, SSF and SISF.

The overall (sex-combined) mean and SD of height, weight, arm span, RAL, LAL, MUAC, NC, SH, WC, HC, TSF, BSF, SSF and SISF were 154.12 cm ± 7.66, 54.32 kg ± 9.56, 156.96 cm ± 8.95, 65.38 cm ± 3.82, 65.16 cm ± 3.82, 25.44 cm ± 2.71, 33.35 cm ± 2.92, 83.80 cm ± 4.40, 81.62 cm ± 9.25, 88.95 cm ± 7.02, 8.90 mm ± 4.12, 4.89 mm ± 2.36, 11.38 mm ± 4.53, and 9.14 mm ± 4.35, respectively in the present study. The sex specific mean and SD values of height (159.43 cm ± 5.89 vs. 148.81 cm ± 5.11), weight (57.18 kg ± 8.86 vs. 51.46 kg ± 9.38), arm span (163.06 cm ± 6.53 vs. 150.86 cm ± 6.57), RAL (67.72 cm ± 3.00 vs. 63.04 cm ± 3.03), LAL (67.52 cm ± 2.99 vs. 62.79 cm ± 3.01), MUAC (26.18 cm ± 2.46 vs. 24.70 cm ± 2.77), NC (35.16 cm ± 2.34 vs. 31.53 ± 2.23), and SH (86.92 cm ± 3.10 vs. 80.67 cm ± 3.09) were higher among males. In contrast the sex specific mean and SD values of WC (80.03 cm ± 7.44 vs. 83.22 cm ± 10.54), HC (87.95 cm ± 5.66 vs. 89.95 cm ± 8.04), TSF (6.81 mm ± 2.95 vs. 10.99 mm ± 4.07), BSF (3.97 mm ± 1.56 vs. 5.80 mm

± 2.65), SSF (10.57 mm ± 4.42 vs. 12.18 mm ± 4.49) and SISF (7.76 mm ± 3.63 vs. 10.53 mm ± 4.56) were higher among females.

The ANOVA was utilised to assess sex differences in mean values of age and anthropometric variables taken in the study (Table 3.2). The results of ANOVA between sexes in height (F = 920.17; d.f.1; $p<0.001$), weight (F=97.54; d.f.1; $p<0.001$), arm span (F= 860.41; d.f.1; $p< 0.001$), RAL (F= 597.19; d.f.1; $p<0.001$), LAL (F = 616.95; d.f.1; $p<0.001$), MUAC (F=78.95; d.f.1; $p<0.001$), NC (F=624.82; d.f.1; $p<0.001$), SH (F= 1013.49; d.f.1; $p<0.001$), WC (F=30.36; d.f.1; $p<0.001$), HC (F= 20.52; d.f.1; $p<0.001$), TSF (F= 344.13; d.f.1; $p<0.001$), BSF (F=177.19; d.f.1; $p<0.001$), SSF (F= 32.41; d.f.1; $p<0.001$), and SISF (F=112.35; d.f.1; $p<0.001$) were significant ($p<0.001$).

3.2.2 GENERAL DESCRIPTIVE STATISTICS OF DERIVED INDICES OF NUTRITIONAL STATUS AND BODY COMPOSITION

Table 3.3 depicts the overall and sex-specific mean (SD) of various derived indices of nutritional status and body composition. The indices of nutritional status derived for the present study from above mention anthropometric variables are BMI, BAI, WHtR, WHR, CI and CRI. The overall mean (SD) of BMI (22.85 kg/m^2 ± 3.53), BAI (28.68% ± 4.82), WHtR (0.53 ± 0.07), WHR (0.91 ± 0.07), CI (1.27 ± 0.09) and CRI (0.54 ± 0.01), TUA (52.10 cm^2 ±11.20), UMA (48.51 cm^2 ±10.32), AFI (6.82 ± 2.87), UFA (3.59 cm^2 ±1.85) and BFMA (40.26 cm^2 ± 9.84), PBF (18.48% ± 7.56), FM (10.21 kg ± 5.04), FFM (44.12 kg ± 7.76), FMI (4.38 kg/m^2 ± 2.26) and FFMI (18.45 kg/m^2 ± 2.25).

The indices significantly high among the female Limboo individuals were BMI (23.21 kg/m^2 ± 3.83 vs. 22.48 kg/m^2 ± 3.18), BAI (31.60% ± 4.47 vs. 25.75% ±

3.08), WHtR (0.56 ± 0.07 vs. 0.50 ± 0.05), WHR (0.93 ± 0.09 vs. 0.91 ± 0.06) and CI (1.30 ± 0.10 vs. 1.23 ± 0.06) compared to male Limboo individuals. The CRI (0.55 ± 0.01 vs. 0.54 ± 0.02) was significantly high among the male Limboo individuals. Further, the mean of TUA (55.02 cm^2 ± 10.47 vs. 49.17 cm^2 ± 11.15), UMA (52.16 cm^2 ± 9.54 vs. 44.85 cm^2 ± 9.77), FFM (49.55 kg ± 5.73 vs. 38.68 kg ± 5.35) and FFMI (19.49 kg/m^2 ± 1.92 vs. 17.45 kg/m^2 ± 2.10) were high among the male Limboo individuals (Table 3.3). On the other hand indices and body composition components like UFA (4.32 cm^2 ± 1.94 vs. 2.86 cm^2 ± 1.43), AFI (8.57 ± 2.60 vs. 5.06 ±1.88), PBF (24.20% ± 4.80 vs. 12.76% ± 5.09), FM (12.77 kg ± 4.60 vs. 7.63 kg ± 4.04) and FMI (5.76 kg/m^2 ± 1.99 vs. 3.00 kg/m^2 ± 1.57) were high among the female Limboo individuals compared to male individuals. Using ANOVA, sex differences in the means of body composition indices and its components were found significant ($p < 0.001$) for the Limboo individuals. The respective ANOVA results obtained were as follows for BMI (F = 10.51; d.f.1; p < 0.001), BAI (F= 575.35; d.f.1; p<0.001), WHtR (F= 225.84; d.f.1; p<0.001), WHR (F= 11.88; d.f.1; p<0.001), CI (F= 205.86; d.f.1; p<0.001), CRI (F= 11.26; d.f.1; p<0.001), TUA (F= 72.58; d.f.1; p<0.001), UMA (F= 142.24; d.f.1; p<0.001), UFA (F= 183.15; d.f.1; p<0.001), AFI (F= 595.26; d.f.1; p<0.001), BFMA (F= 38.67; d.f.1; p<0.001), PBF (F= 1325.25; d.f.1; p<0.001), FM (F= 349.80; d.f.1; p<0.001), FFM (F= 952.12; d.f.1; p<0.001), FMI (F= 589.80; d.f.1; p<0.001), FFMI (F= 253.01; d.f.1; p<0.001).

Table 3.2: Descriptive statistics of age and anthropometric characteristics of the Limboo individuals

Variables	Overall (n = 992)	Male (n = 496)	Female (n = 496)	*F*-value
	Mean ± SD	Mean ± SD	Mean ± SD	
Age (years)	34.73 ± 12.47	35.71 ± 12.78	33.74 ± 12.09	6.535*
Height (cm)	154.12 ± 7.66	159.43 ± 5.89	148.81 ± 5.11	920.17**
Weight (kg)	54.32 ± 9.56	57.18 ± 8.86	51.46 ± 9.38	97.54**
Armspan (cm)	156.96 ± 8.95	163.06 ± 6.53	150.86 ± 6.57	860.41**
RAL (cm)	65.38 ± 3.82	67.72 ± 3.00	63.04 ± 3.03	597.19**
LAL (cm)	65.16 ± 3.82	67.52 ± 2.99	62.79 ± 3.01	616.95**
MUAC (cm)	25.44 ± 2.71	26.18 ± 2.46	24.70 ± 2.77	78.95**
NC (cm)	33.35 ± 2.92	35.16 ± 2.34	31.53 ± 2.23	624.82**
WC (cm)	81.62 ± 9.25	80.03 ± 7.44	83.22 ± 10.54	30.36**
HC (cm)	88.95 ± 7.02	87.95 ± 5.66	89.95 ± 8.04	20.52**
SH (cm)	83.80 ± 4.40	86.92 ± 3.10	80.67 ± 3.09	1013.49**
TSF (mm)	8.90 ± 4.12	6.81 ± 2.95	10.99 ± 4.07	344.13**
BSF (mm)	4.89 ± 2.36	3.97 ± 1.56	5.81 ± 2.65	177.19**
SSF (mm)	11.38 ± 4.53	10.57 ± 4.42	12.18 ± 4.50	32.41**
SISF (mm)	9.14 ±4.35	7.76 ± 3.63	10.53 ± 4.56	112.35**

** p<0.001; * p<0.05; d.f . = 1, SD = Standard deviation

Table 3.3: Descriptive statistics of derived nutritional and body composition indices of the Limboo individuals

Variables	Overall (n = 992)	Male (n = 496)	Female (n = 496)	*F*-value
	Mean ± SD	Mean ± SD	Mean ± SD	
BMI (kg/m^2)	22.85 ± 3.53	22.48 ± 3.17	23.21 ± 3.83	10.51**
BAI (%)	28.68 ± 4.82	25.75 ± 3.08	31.60 ± 4.47	575.35**
WHtR	0.53 ± 0.07	0.50 ± 0.05	0.56 ± 0.07	225.84**
WHR	0.92 ± 0.07	0.91 ± 0.06	0.93 ± 0.09	11.88**
CI	1.27 ± 0.09	1.23 ± 0.06	1.30 ± 0.10	205.86**
CRI	0.54 ± 0.02	0.55 ± 0.01	0.54 ± 0.02	11.26**
TUA (cm^2)	52.10 ± 11.20	55.02 ± 10.47	49.18 ± 11.15	72.58**
UMA (cm^2)	48.51 ± 10.32	52.17 ± 9.54	44.85 ± 9.77	142.24**
UFA (cm^2)	3.59 ± 1.85	2.86 ± 1.43	4.32 ± 1.94	183.15**
AFI	6.82 ± 2.87	5.06 ± 1.86	8.57 ± 2.61	595.26**
BFMA (cm^2)	40.26 ± 9.84	42.17 ± 9.54	38.35 ± 9.77	38.67**
PBF (%)	18.48 ± 7.56	12.76 ± 5.09	24.20 ± 4.80	1325.25**
FM (kg)	10.21 ± 5.04	7.63 ± 4.04	12.78 ± 4.60	349.80**
FFM (kg)	44.12 ± 7.76	49.55 ± 5.73	38.68 ± 5.38	952.12**
FMI (kg/m^2)	4.38 ± 2.26	3.00 ± 1.57	5.76 ± 1.99	589.80**
FFMI (kg/m^2)	18.45 ± 2.25	19.49 ± 1.93	17.45 ± 2.10	253.01**

** p<0.001; * p<0.05; d.f. = 1, SD = Standard deviation

3.2.3 AGE SPECIFIC DESCRIPTIVE STATISTICS OF AGE AND ANTHROPOMETRIC VARIABLES

The individuals have been categorised into three age group viz. 18-29 years, 30-49 years and 50-64 years. The mean (SD) and ANOVA results of anthropometric variables of each age groups mention above are presented in Table 3.4. The mean values of age within the age groups 18-29 years, 30-49 years and 50-64 years were 23.33 years (± 3.57), 38.15 years (± 6.23), and 55.65 years (± 4.23), respectively for Limboo males. Among the female individuals mean of age within age groups were 22.76 years (± 3.34), 37.71 years (± 5.77), and 54.52 years (± 3.76), respectively. The observed mean value of weight, arm span, RAL, LAL, MUAC, NC, WC, HC, TSF, BSF, SSF and SISF were high among 30-49 years age group compared to 18-29 years and 50-64 years adult males except height and SH which were high among males of 18-29 years. Similarly, among females the observed mean value of weight, MUAC, NC, WC, HC, TSF, BSF, SSF and SISF were high among 30-49 years age group compared to 18-29 years and 50-64 years adult females except height, SH, and arm span, which were higher among 18-29 years female adults. In contrast to males among females the mean values of RAL and LAL were higher among 50-64 years age group.

The result of ANOVA between above mention age groups showed significant ($p<0.05$) effect of age on the anthropometric variables used in the present study except for arm span, RAL and LAL among male and female Limboo individuals. The decreasing trend with increasing age in case of the height and SH among the Limboo individuals of both sexes were observed to be significant ($p < 0.001$). The results of ANOVA between age groups of males and females Limboo individuals are presented in Table 3.4.

However, post hoc analyses have revealed the significant difference between 30-49 years and 50-64 years age group in height, SH, TSF of males and height, SH, TSF, BSF, and SISF of females in the present study. The measurements like NC, WC, and HC were observed increased in 30-49 years age group from 18-29 years based on post hoc analyses. The measurements observed rising during 30-49 years and declining in 50-64 years of age were MUAC, BSF, SSF, and SISF among males and weight, MUAC, and SSF among females of the present study. Irrespective of sex, the decline in height, SH, skinfolds and MUAC during 50-64 years was observed. Similarly, the increase in NC, WC and HC was observed during middle age around 30-49 years.

3.2.4 AGE SPECIFIC DESCRIPTIVE STATISTICS OF DERIVED ANTHROPOMETRIC AND BODY COMPOSITION INDICES

As mentioned earlier the samples has been categorised into three age groups viz. 18-29 years, 30-49 years, and 50-64 years. The mean (SD) of derived anthropometric and body composition indices with results of ANOVA of each age groups are presented in Table 3.5. Among the male Limboo individuals mean of indices like BAI, WHtR, WHR, and CI were observed to be increasing across the age groups from 18-29 years to 50-64 years age group. Instead, among female Limboo individuals mean of BMI, BAI, WHtR and WHR were high for 30-49 year age adults compared to 18-29 years adults and 50-64 year adults, which also holds for mean BMI among male individuals (Table 3.5). The observed F values for BMI ($F= 16.90$; d.f.2; $p<0.001$), BAI ($F= 14.72$; d.f.2; $p<0.001$), WHtR ($F= 34.82$; d.f.2; $p<0.001$), WHR ($F= 23.16$; d.f.2; $p<0.001$) and CI ($F= 28.69$; d.f.2; $p<0.001$) were significant among male Limboo individuals. Similarly observed F values of BMI ($F= 23.70$; d.f.2; $p<0.001$), BAI ($F= 11.99$; d.f.2; $p<0.001$), WHtR ($F=24.37$; d.f.2; $p<0.001$) and

WHR (F= 12.91; d.f.2; p<0.001) were significant among female Limboo individuals. Among female Limboo individuals the mean of CI was observed increasing significantly (F= 7.43; d.f.2; p<0.001).

However, post hoc analyses revealed the significant difference between 18-29 years and 30-49 years age group in the indices like BMI, BAI, WHtR, WHR, CI, FFM and FFMI among males. Similarly, these indices excluding BMI were significantly different between the 18-29 year and 30-49 years age groups females. The change in mean BMI values across the age group among females was supported by post hoc analysis.

The mean values of CRI remained stable across the age groups among both male and female Limboo individuals which were statistically significant (p<0.05) among females. The observed mean values of TUA, UMA, UFA, AFI, BFMA, PBF, FM, and FMI of male and female Limboo individuals were higher among middle age group (30-49 years) compared to young adults (18-29 years) and old adults (50-64 years). The ANOVA results between age groups were significant for these indices as shown in Table 3.5. On the post hoc analyses the indices like TUA, UMA, BFMA, FM, and FMI was observed significantly different across each age groups of both male and female Limboo individuals. Similar, post hoc analyses results were obtained for UFA, BD and PBF among male Limboo individuals. AFI among male and CRI, UFA, AFI, BD, and PBF among female Limboo individuals have observed difference between the 30-49 years and 50-64 years of age groups on post hoc analyses in the present study.

Table 3.4: Age and sex specific descriptive statistics (mean ± SD) of anthropometric measurements of the Limboo individuals

Variables	Male			F-value	Female			F-value
	18-29 yrs	30-49 yrs	50-64 yrs		18-29 yrs	30-49 yrs	50-64 yrs	
Age (years)	23.33 ± 3.57	38.15 ± 6.23	55.65 ± 4.23	1327.36 **	22.76 ± 3.34	37.71 ± 5.77	54.52 ± 3.76	1484.09**
Height (cm)	159.94 ± 6.11	159.67 ± 5.49	157.81 ± 6.12	4.38*	149.41 ± 5.10	148.55 ± 5.06	147.81 ± 5.12	3.20*
Weight (kg)	54.98 ± 7.58	59.24 ± 9.09	56.88 ± 9.66	12.29**	49.18 ± 8.11	54.15 ± 9.70	50.70 ± 10.13	15.94**
Arm span (cm)	162.70 ± 6.54	163.68 ± 6.45	162.33 ± 6.62	1.82	151.15 ± 6.52	150.56 ± 6.27	150.80 ± 7.53	0.42
RAL (cm)	67.54 ± 3.12	67.89 ± 2.97	67.70 ± 2.84	0.72	63.10 ± 2.89	62.92 ± 3.03	63.20 ± 3.43	0.30
LAL (cm)	67.33 ± 3.07	67.70 ± 2.96	67.52 ± 2.90	0.75	62.88 ± 2.81	62.64 ± 3.07	62.92 ± 3.41	0.41
MUAC (cm)	25.66 ± 2.20	26.78 ± 2.47	25.86 ± 2.64	12.00**	23.98 ± 2.49	25.65 ± 2.69	24.22 ± 3.02	22.36**
NC (cm)	34.63 ± 1.99	35.61 ± 2.57	35.21 ± 2.25	9.05**	30.84 ± 1.92	32.20 ± 2.29	31.68 ± 2.35	21.25**
WC (cm)	76.88 ± 6.31	82.01± 7.19	81.85 ± 8.00	30.62**	80.08 ± 9.05	86.31±10.63	83.8 ± 11.71	19.95**
HC (cm)	86.48 ± 5.11	89.18 ± 5.59	88.11± 6.25	12.06**	88.49 ± 6.48	91.44 ± 8.68	90.12 ± 0.52	7.25**
SH (cm)	87.19 ± 3.25	87.06 ± 2.82	86.05 ± 3.26	4.63*	81.20 ± 3.29	80.58 ± 2.87	79.41 ± 2.69	9.78**
TSF (mm)	6.69 ± 2.78	7.25 ± 3.13	6.02 ± 2.66	5.92**	11.22 ± 3.62	11.38 ± 4.24	9.27 ± 4.39	8.25**
BSF (mm)	3.76 ± 1.37	4.29 ± 1.71	3.65 ± 1.43	8.28**	5.65 ± 2.33	6.23 ± 2.93	5.10 ± 2.51	5.76**
SSF (mm)	9.70 ± 3.65	11.64 ± 5.02	9.83 ± 3.80	11.78**	11.73 ± 4.03	13.29 ± 4.72	10.44 ± 4.44	13.58**
SISF (mm)	7.17 ± 3.14	8.51 ± 3.91	7.20 ± 3.63	8.38**	10.81 ± 4.06	10.78 ± 4.87	9.03 ± 4.77	4.85*

** p<0.001; * p<0.05; d.f. = 2, SD = Standard deviation

Table 3.5: Age and sex specific descriptive statistics (mean ± SD) of nutritional status and body composition indices of the Limboo individuals

Variables	Male			F-value	Female			F-value
	18-29 yrs	30-49 yrs	50-64 yrs		18-29 yrs	30-49 yrs	50-64 yrs	
BMI (kg/m^2)	21.48 ± 2.61	23.23 ± 3.34	22.79 ± 3.27	16.90**	22.01 ± 3.28	24.47± 3.77	23.20 ± 4.36	23.70**
BAI (%)	24.83 ± 3.00	26.25 ± 2.95	26.49 ± 3.09	14.72**	30.51 ± 3.65	32.51± 4.52	32.24 ± 5.69	11.99**
WHtR	0.48 ± 0.04	0.51 ± 0.05	0.52 ± 0.05	34.82**	0.54 ± 0.06	0.58 ± 0.07	0.57 ± 0.08	24.37**
WHR	0.89 ± 0.05	0.92 ± 0.06	0.93 ± 0.06	23.16**	0.90 ± 0.07	0.95 ± 0.09	0.93 ± 0.10	12.91**
CI	1.21 ± 0.06	1.24 ± 0.05	1.25 ± 0.06	28.69**	1.28 ± 0.08	1.31 ± 0.09	1.32 ± 0.13	7.43**
CRI	0.55 ± 0.01	0.55 ± 0.01	0.55 ± 0.01	0.00	0.54 ± 0.02	0.54 ± 0.01	0.54 ± 0.01	4.20*
TUA (cm^2)	52.76 ± 9.21	57.54 ± 10.60	53.74 ± 11.38	11.84**	46.23 ± 9.76	52.93 ± 11.21	47.40 ± 11.88	21.80**
UMA (cm^2)	50.02 ± 8.36	54.43 ± 9.60	51.25 ± 10.57	11.80**	41.96 ± 8.39	48.30 ± 9.89	43.77 ± 10.29	24.83**
UFA (cm^2)	2.75 ± 1.32	3.11 ± 1.52	2.50 ± 1.32	7.07**	4.27 ± 1.74	4.63 ± 2.02	3.63 ± 2.11	7.66**
AFI	5.08 ± 1.81	5.25 ± 1.96	4.55 ± 1.72	4.59*	9.03 ± 2.30	8.55 ± 2.71	7.32 ± 2.75	12.55**
BFMA (cm^2)	40.02 ± 8.36	44.43 ± 9.60	41.25 ± 10.57	11.80**	35.46 ± 8.39	41.80 ± 9.89	37.27 ± 10.29	24.83**
BD (cm^3)	1.07 ± 0.01	1.07 ± 0.01	1.07 ± 0.01	9.33**	1.04 ± 0.01	1.04 ± 0.01	1.05 ± 0.01	12.06**
PBF (%)	12.06 ± 4.45	13.86 ± 5.48	11.62 ± 4.90	9.42**	24.34 ± 4.17	24.91 ± 5.00	21.84 ± 5.24	11.93**
FM (kg)	6.86 ± 3.40	8.59 ± 4.36	6.97 ± 4.05	11.16**	12.22 ± 3.99	13.85 ± 4.88	11.47 ± 4.92	10.54**
FFM (kg)	48.11 ± 5.11	50.65 ± 5.11	49.91 ± 6.40	10.48**	30.96 ± 4.56	40.30 ± 5.41	39.23 ± 5.83	22.80**
FMI (kg/m^2)	2.68 ± 1.32	3.37 ± 1.70	2.77 ± 1.53	11.18**	5.46 ± 1.71	6.24 ± 2.08	5.26 ± 2.20	11.40**
FFMI (kg/m^2)	18.80 ± 1.59	19.86 ± 1.98	20.01 ± 2.05	21.15**	16.55 ± 1.76	18.22 ± 1.95	17.95 ± 2.38	42.09**

** $p<0.001$; * $p<0.05$; d.f. = 2, SD = Standard deviation

3.2.5 CORRELATIONS OF ANTHROPOMETRIC VARIABLE AMONG THE MALE LIMBOO INDIVIDUALS

The Pearson correlation values between different anthropometric variables of male Limboo individuals are shown in Table 3.6. The age was positively and significantly correlated with weight (r = 0.156, p<0.01), MUAC (r = 0.112, p<0.01), NC (r = 0.144, p<0.01), WC (r = 0.327, p<0.01), HC (r = 0.164, p<0.01), SSF (r = 0.090, p<0.01), BMI (r = 0.234, p<0.01), BAI (r = 0.250, p<0.01), WHtR (r = 0.370, p<0.01), WHR (r = 0.319, p<0.01), CI (r = 0.339, p<0.01), TUA (r = 0.117, p<0.01), UMA (r = 0.131, p<0.01), FM (r = 0.088, p<0.05), FFM (r = 0.178, p<0.01), FMI (r = 0.102, p<0.05) and FFMI (r = 0.303, p<0.01) among the male Limboo individuals. The negatively and significantly correlated variables with age were height (r = -0.130, p<0.01) and SH (r = -0.114, p<0.05) among the male Limboo individuals. The observed strength of association was low.

The height was positively and significantly correlated with weight (r = 0.411,p<0.01), arm span (r = 0.788, p<0.01), RAL (r = 0.794, p<0.01), LAL (r = 0.787, p<0.01), MUAC (r = 0.100, p<0.05), NC (r = 0.197, p<0.01), WC (r = 0.145, p<0.01), HC (r = 0.330, p<0.01), SH (r = 0.783, p<0.01), CRI (r= -0.381, p<0.01), TUA (r = 0.098, p<0.05), UMA (r = 0.102, p<0.05), FM (r = 0.160, p<0.01), and FFM (r = 0.523, p<0.01) among the male Limboo individuals. The negatively and significantly correlated variables with height beside age were WHtR (r = -0.253, p<0.01), WHR (r = -0.134, p<0.01), and FFMI (r = -0.139, p<0.01) among the male Limboo individuals. The height was correlated strongly with only linear measurements among male Limboo individuals.

The weight was positively and significantly correlated with arm span (r = 0.392, p<0.01), RAL (r = 0.341, p<0.01), LAL (r = 0. 343, p<0.01), MUAC (r =

0.770, p<0.01), NC (r = 0.740, p<0.01), WC (r = 0.838,p<0.01), HC (r = 0.860, p<0.01), SH (r = 0.453, p<0.01), TSF (r = 0.612, p<0.01), BSF (r = 0.693, p<0.01), SSF (r = 0.700, p<0.01), SISF (r = 0.657, p<0.01), BMI (r = 0.876, p<0.01), BAI (r = 0.456, p<0.01), WHtR (r = 0.653, p<0.01), WHR (r = 0.346, p<0.01), CI (r = 0.172, p<0.01), TUA (r = 0.769, p<0.01), UMA (r = 0.742, p<0.01), UFA (r = 0.680, p<0.01), AFI (r = 0.499, p<0.01), PBF (r = 0.746, p<0.01), FM (r = 0.864,p<0.01), FMI (r = 0.814, p<0.01), FFM (r = 0.935, p<0.01) and FFMI (r = 0.777, p<0.01) among the male Limboo individuals. The correlations of weight with other anthropometric variables were strong except for BAI, WHR, and CI.

The armspan was positively and significantly correlated with RAL (r = 0.900, p<0.01), LAL (r =0.910, p<0.01), MUAC (r = 0.100, p<0.05), NC (r = 0.181, p<0.01), WC (r = 0.181, p<0.01), HC (r = 0.319, p<0.01), SH (r = 0.540, p<0.01), CRI (r= -0.408, p<0.01), TUA (r = 0.097, p<0.05), UMA (r = 0.102, p<0.05), FM (r =0.131, p<0.01), and FFM (r = 0.513, p<0.01) among the male Limboo individuals. The negatively and significantly correlated variables with armspan were BAI (r = -0.333, p<0.01) and WHtR (r = -0.134, p<0.01) and. The arm span was observed strongly correlated with only linear anthropometric measurements such as RAL and LAL.

Similarly, RAL was positively and significantly correlated with LAL (r =0.977, p<0.01), NC (r = 0.149, p<0.01), WC (r = 0.159, p<0.01), HC (r = 0.280, p<0.01), SH (r = 0.516, p<0.01), UMA (r = 0.090, p<0.05), FM (r = 0.099, p<0.05), and FFM (r = 0.457, p<0.01) among the male Limboo individuals. The negatively and significantly correlated variables with RAL were BAI (r = -0.375, p<0.01), WHtR (r = -0.158, p<0.01), and CRI (r= -0.454, p<0.01), among the male Limboo individuals. The strong correlation was only observed with LAL. The LAL itself was positively and significantly correlated with MUAC (r = 0.094, p<0.05), NC (r = 0.165, p<0.01), WC (r = 0.166, p<0.01), HC (r = 0.277, p<0.01), SH (r = 0.499, p<0.01), TUA (r = 0.093, p<0.05), UMA (r = 0.100, p<0.05), FM (r = 0.103, p<0.01) and FM (r = 0.458, p<0.01). The negatively and significantly correlated variables with LAL were BAI (r = -0.372, p<0.01), WHtR (r = -0.148, p<0.01), and CRI (r= -0.469, p<0.01).The correlations of LAL with the remaining anthropometric measurements and indices were low.

Among the male Limboo individuals, MUAC was positively and significantly correlated with NC (r = 0.636, p<0.01), WC (r = 0.699, p<0.01), HC (r = 0.681, p<0.01), SH (r = 0.170, p<0.01), TSF (r = 0.567, p<0.01), BSF (r = 0.602, p<0.01), SSF (r = 0.632, p<0.01), SISF (r = 0.627, p<0.01), BMI (r = 0.789, p<0.01), BAI (r = 0.540, p<0.01), WHtR (r = 0.640, p<0.01), WHR (r = 0.328, p<0.01), CI (r = 0.151, p<0.01), CRI (r= 0.095, p<0.01), TUA (r = 0.998, p<0.01), UMA (r = 0.992, p<0.01), UFA (r = 0.684, p<0.01), AFI (r = 0.392, p<0.01), PBF (r = 0.683,p<0.01), FM (r = 0.739, p<0.01), FMI (r = 0.735, p<0.01), FFM (r = 0.667, p<0.01), and FFMI (r = 0.699, p<0.01). The most of the observed correlation were strong except with SH, CI, CRI, WHR, and AFI.

The NC was positively and significantly correlated with WC (r = 0.658,p<0.01), HC (r = 0.651, p<0.01), SH (r = 0.258, p<0.01), TSF (r = 0.460, p<0.01), BSF (r = 0.530, p<0.01), SSF (r = 0.638, p<0.01), SISF (r = 0.574, p<0.01), BMI (r = 0.706, p<0.01), BAI (r = 0.435, p<0.01), WHtR (r = 0.563, p<0.01), WHR (r = 0.301, p<0.01), CI (r = 0.161, p<0.01), TUA (r = 0.626, p<0.01), UMA (r = 0.609, p<0.01), UFA (r = 0.523, p<0.01), AFI (r = 0.355, p<0.01), PBF (r = 0.618, p<0.01), FM (r = 0.693, p<0.01), FFM (r = 0.654, p<0.01), FMI (r = 0.671, p<0.01), and FFMI (r = 0.615, p<0.01). All correlations of NC were strong except with SH, TSF, BAI, WHR, CI, and AFI.

The WC was positively and significantly correlated with HC (r = 0.765,p<0.01), SH (r = 0.198, p<0.01), TSF (r = 0.631, p<0.01), BSF (r = 0.678, p<0.01), SSF (r = 0.707, p<0.01), SISF (r = 0.694, p<0.01), BMI (r = 0.838, p<0.01), BAI (r = 0.583, p<0.01), WHtR (r = 0.920, p<0.01), WHR (r = 0.700, p<0.01), CI (r = 0.649, p<0.01), TUA (r = 0.700, p<0.01), UMA (r = 0.666, p<0.01), UFA (r = 0.684, p<0.01), AFI (r = 0.538, p<0.01), PBF (r = 0.756,p<0.01), FM (r = 0.825, p<0.01), FFM (r = 0.713, p<0.01), FMI (r = 0.812, p<0.01) and FFMI (r = 0.718,p<0.01). Except with SH all the correlations were strong.

The HC was positively and significantly correlated with SH (r = 0.386, p<0.01), TSF (r = 0.595, p<0.01), BSF (r = 0.610, p<0.01), SSF (r = 0.627, p<0.01), SISF (r = 0.616, p<0.01), BMI (r = 0.769, p<0.01), BAI (r = 0.654, p<0.01), WHtR (r = 0.616, p<0.01), CI (r = 0.216, p<0.01), TUA (r = 0.677, p<0.01), UMA (r = 0.646, p<0.01), UFA (r = 0.647, p<0.01), AFI (r = 0.502, p<0.01), PBF (r = 0.681, p<0.01), FM (r = 0.768, p<0.01), FM (r = 0.786, p<0.01), FMI (r = 0.732, p<0.01), and FFMI (r = 0.668, p<0.01). The correlations observed were strong with HC except for SH, CI, FFM, and FFMI.

The SH was positively and significantly correlated with BSF (r = 0.130, p<0.01), SSF (r = 0.150, p<0.01), SISF (r = 0.135, p<0.01), CRI (r= 0.276, p<0.01), TUA (r = 0.169, p<0.01), UMA (r = 0.171, p<0.01), UFA (r = 0.099, p<0.05), PBF (r = 0.150, p<0.01), FM (r = 0.244, p<0.01), FFM (r = 0.528, p<0.01), and FMI (r = 0.135, p<0.01). The negatively and significantly correlated variables with SH were BAI (r = -0.272, p<0.01), WHtR (r = -0.116, p<0.01), WHR (r = -0.113, p<0.05). The correlations observed were low. Similarly ratio of leg trunk, correlations of CRI was low with other variables and indices except with RAL and LAL.

The TSF was positively and significantly correlated with BSF (r = 0.800, p<0.01), SSF (r = 0.721, p<0.01), SISF (r = 0.770, p<0.01), BMI (r = 0.661, p<0.01), BAI (r = 0.532, p<0.01), WHtR (r = 0.610, p<0.01), WHR (r = 0.317, p<0.01), CI (r = 0.247, p<0.01), TUA (r = 0.569, p<0.01), UMA (r = 0.476, p<0.01), UFA (r = 0.985, p<0.01), AFI (r = 0.976, p<0.01), PBF (r = 0.875, p<0.01), FM (r = 0.849, p<0.01), FFM (r = 0.346, p<0.01), FMI (r = 0.859, p<0.01), and FFMI (r = 0.388, p<0.01). The observed correlations were strong except with CI, UMA, FFM and FFMI.

The BSF was positively and significantly correlated with SSF (r = 0.781,p<0.01), SISF (r = 0.765, p<0.01), BMI (r = 0.723, p<0.01), BAI (r = 0.500, p<0.01), WHtR (r = 0.632, p<0.01), WHR (r = 0.366, p<0.01), CI (r = 0.231, p<0.01), TUA (r = 0.609, p<0.01), UMA (r = 0.545, p<0.01), UFA (r = 0.822, p<0.01), AFI (r = 0.740, p<0.01), PBF (r = 0.860, p<0.01), FM (r = 0.875, p<0.01) FFM (r = 0.453, p<0.01), FMI (r = 0.879, p<0.01) and FFMI (r = 0.473, p<0.01) among the male Limboo individuals. The observed correlations were strong except with WHR, CI, FFM, and FFMI.

The SSF was positively and significantly correlated with SISF (r = 0.778, p<0.01), BMI (r = 0.747, p<0.01), BAI (r = 0.539, p<0.01), WHtR (r = 0.673, p<0.01), WHR (r = 0.395, p<0.01), CI (r = 0.257, p<0.01), CRI (r= 0.154, p<0.01), TUA (r = 0.635, p<0.01), UMA (r = 0.584, p<0.01), UFA (r = 0.753, p<0.01), AFI (r = 0.649, p<0.01), PBF (r = 0.905,p<0.01), FM (r = 0.903, p<0.01), FFM (r = 0.445,p<0.01), FMI (r = 0.910, p<0.01) and FFMI (r = 0.488, p<0.01) among the male Limboo individuals. The correlations observed were strong except with WHR and CI.

The SISF was positively and significantly correlated with BMI (r = 0.713, p<0.01), BAI (r = 0.522, p<0.01), WHtR (r = 0.657, p<0.01), WHR (r = 0.389, p<0.01), CI (r = 0.278, p<0.01), SISF (r= 0.123, p<0.01),TUA (r = 0.628, p<0.01), UMA (r = 0.570, p<0.01), UFA (r = 0.795, p<0.01), AFI (r = 0.704, p<0.01), PBF (r = 0.909, p<0.01), FM (r = 0.895, p<0.01), FFM (r = 0.411, p<0.01), FMI (r = 0.899, p<0.01), and FM (r = 0.441, p<0.01) among the male Limboo individuals. The correlations observed were strong except with WHR, CI, FFM, and FFMI.

The BMI was positively and significantly correlated with BAI (r = 0.764, p<0.01), WHtR (r = 0.847, p<0.01), WHR (r = 0.444, p<0.01), CI (r = 0.185, p<0.01), CRI (r = 0.240, p<0.01), TUA (r = 0.788, p<0.01), UMA (r = 0.756, p<0.01), UFA (r = 0.725, p<0.01), AFI (r = 0.551, p<0.01), PBF (r = 0.791, p<0.01), FM (r = 0.861, p<0.01), FFM (r = 0.745, p<0.01), FMI (r = 0.884, p<0.01) and FFMI (r = 0.925, p<0.01) among the male Limboo individuals. The correlations of BMI were strong with anthropometric measurements and indices except with WHR, CI, and CRI.

The BAI was positively and significantly correlated with WHtR (r = 0.767, p<0.01), WHR (r = 0.173, p<0.01), CI (r = 0.199, p<0.01), CRI (r= 0.361, p<0.01), TUA (r = 0.538, p<0.01), UMA (r = 0.506, p<0.01), UFA (r = 0.563, p<0.01), AFI (r = 0.551, p<0.01), PBF (r = 0.581, p<0.01), FM (r = 0.574, p<0.01), FFM (r = 0.300, p<0.01), FMI (r = 0.654, p<0.01) and FFMI (r = 0.723, p<0.01) among the male Limboo individuals. The observed correlations were strong except for WHR, CI, CRI, and FFM.

The WHtR was positively and significantly correlated with WHR (r = 0.738, p<0.01), CI (r = 0.639, p<0.01), TUA (r = 0.642, p<0.01), UMA (r = 0.607, p<0.01), UFA (r = 0.653, p<0.01), AFI (r = 0.529, p<0.01), PBF (r = 0.717, p<0.01), FM (r =

0.740, p<0.01), FFM (r = 0.487,p<0.01), FMI (r = 0.784,p<0.01) and FFMI (r = 0.755, p<0.01) among the male Limboo individuals. The observed correlations were strong. Similarly another ratio of central obesity is WHR. The WHR was positively and significantly correlated with CI (r = 0.765, p<0.01), TUA (r = 0.332, p<0.01), UMA (r = 0.314, p<0.01), UFA (r = 0.340, p<0.01), AFI (r = 0.277, p<0.01), PBF (r = 0.417, p<0.01), FM (r = 0.423, p<0.01), FFM (r = 0.236, p<0.01), FMI (r = 0.443, p<0.01) and FFMI (r = 0.370, p<0.01) among the male Limboo individuals. The only strong correlation of WHR was observed with CI. The index of central obesity CI can be observed with strong positive correlations with WC, WHtR, and WHR. Remaining correlations with CI were all low.

The TUA was positively and significantly correlated with UMA (r = 0.994, p<0.01), UFA (r = 0.689, p<0.01), AFI (r = 0.392, p<0.01), PBF (r = 0.681, p<0.01), FM (r = 0.742, p<0.01), FFM (r = 0.664, p<0.01), FMI (r = 0.737, p<0.01), and FFMI (r = 0.696, p<0.01) among the male Limboo individuals. The observed correlations were strong except AFI. Further, UMA was positively and significantly correlated with UFA (r = 0.606, p<0.01), AFI (r = 0.292, p<0.01), PBF (r = 0.614, p<0.01), FM (r = 0.681, p<0.01), FFM (r = 0.665, p<0.01), FMI (r = 0.676, p<0.01) and FFMI (r = 0.694, p<0.01) among the male Limboo individuals. The correlations with UMA were observed strong except with AFI. Similarly, the UFA was positively correlated with AFI (r = 0.924, p<0.01), PBF (r = 0.889, p<0.01), FM (r = 0.885, p<0.01), FFM (r = 0.426, p<0.01), FMI (r = 0.892, p<0.01), and FFMI (r = 0.467, p<0.01) among the male Limboo individuals. These correlations of UFA were strong and significant except for FFM and FFMI. Furthermore, AFI was positively and significantly correlated with PBF (r = 0.821, p<0.01), FM (r = 0.769, p<0.01), FFM (r = 0.228, p<0.01), FMI (r = 0.782, p<0.01) and FFMI (r = 0.269, p<0.01) among the male

Limboo individuals. The correlations observed were strong except with FFM, and FFMI.

The PBF was positively correlated with FM (r = 0.971, p<0.01), FFM (r = 0.467, p<0.01), FMI (r = 0.978, p<0.01) and FFMI (r = 0.505, p<0.01) among the male Limboo individuals. The correlations were strong and significant. Further, the FM was positively correlated with FFM (r = 0.630, p<0.01), FMI (r = 0.987, p<0.01), and FFMI (r = 0.612, p<0.01) among the male Limboo individuals. The FFM was positively and significantly with FMI (r = 0.561, p<0.01) and FFMI (r = 0.769, p<0.01). The correlation of FMI (r = 0.639, p<0.01) was strong and positive with FFMI.

3.2.6 CORRELATIONS OF ANTHROPOMETRIC VARIABLE AMONG THE FEMALE LIMBOO INDIVIDUALS

The age was weakly correlated with weight (r = 0.145, p<0.01), MUAC (r = 0.131, p<0.01), NC (r= 0.225, p<0.01), WC (r= 0.206, p<0.01), HC (r = 0.134,p<0.01), BMI (r = 0.205, p<0.01), BAI (r = 0.196, p<0.01), WHtR (r = 0.239, p<0.01), WHR (r = 0.158, p<0.01), CI (r = 0.159,p<0.01), CRI (r = -0.106, p<0.01), TUA (r = 0.136,p<0.01), UMA (r = 0.169, p<0.01), FFM (r = 0.240, p<0.01) and FFMI (r = 0.338, p<0.01) among the Limboo female individuals which were positive and significant. On the contrary the age is negatively and significantly correlated with height (r = -0.111, p<0.01), SH (r = -0.183, p<0.01), TSF (r = -0.144, p<0.01), SISF (r = -0.107, p<0.05), AFI (r = -0.235, p<0.01) and PBF (r = -0.136, p<0.01) among the female Limboo individuals and the all the correlations were low.

The height is positively and significantly correlated with weight (r = 0.397, p<0.01), arm span (r = 0.821, p<0.01), RAL (r = 0.764, p<0.01), LAL (r = 0.753, p<0.01), MUAC (r = 0.128, p<0.01), NC (r = 0.235, p<0.01), WC (r = 0.179, p<0.01), HC (r = 0.280, p<0.01), SH (r = 0.676, p<0.01), SISF (r = 0.101, p<0.05), TUA (r = 0.136, p<0.01), UMA (r = 0.135, p<0.01), UFA(r = 0.101, p<0.05), FM (r = 0.259, p<0.01) and FFM (r = 0.473, p<0.01) among the female Limboo individuals. However, correlations between height and body composition parameters were observed to be low. On the contrary height is negatively and significantly correlated with BAI (r = -0.296, p<0.01), WHtR (r = -0.097, p<0.05), and CRI (r = -0.290, p<0.01). The strong correlation of height was observed with arm span, RAL, LAL, SH and all the inversed correlation with height was observed to be low.

The positive significant correlation of weight with MUAC (r = 0.827, p<0.01), NC (r = 0.806, p<0.01), WC (r = 0.823, p<0.01), HC (r = 0.864, p<0.01), SH (r = 0.407, p<0.01), TSF (r = 0.567, p<0.01), BSF (r = 0.653, p<0.01), SSF (r = 0.731, p<0.01), SISF (r = 0.610, p<0.01), BMI (r = 0.923, p<0.01), BAI (r = 0.622, p<0.01), WHtR (r = 0.718, p<0.01), TUA (r = 0.834, p<0.01), UMA (r = 0.817, p<0.01), UFA (r = 0.678, p<0.01), PBF (r = 0.729, p<0.01), FM (r = 0.933, p<0.01), FM (r = 0.951,p<0.01), FMI (r = 0.880, p<0.01) and FFMI (r = 0.851, p<0.01) among the female Limboo individuals were strong. However, correlation with arm span (r = 0.316, p<0.01), RAL (r = 0.295, p<0.01), LAL (r = 0.288, p<0.01), WHR (r = 0.250, p<0.01), CI (r = 0.280, p<0.01), and AFI (r = 0.369, p<0.01) were observed to be low.

The armspan was positively and significantly correlated with RAL (r = 0.867,p<0.01), LAL (r = 0.870, p<0.01), MUAC (r = 0.090, p<0.05), NC (r = 0.172, p<0.01), WC (r = 0.150, p<0.01), HC (r = 0.197, p<0.01), SH (r = 0.470, p<0.01), TUA (r = 0.099, p<0.05), UMA (r = 0.105, p<0.05), FM (r = 0.155, p<0.01) and FFM (r = 0.420, p<0.01) among the female Limboo individuals. On the contrary arm span was negatively and significantly correlated with BAI (r = -0.276, p<0.01) and CRI (r = -0.350, p<0.01). The correlations observed were low except with LAL.

The RAL was positively and significantly correlated with LAL (r = 0.959, p<0.01), MUAC (r = 0.089, p<0.05), NC (r = 0.140, p<0.01), HC (r = 0.197, p<0.01), WC (r = 0.154, p<0.01), SH (r = 0.404, p<0.01), TUA (r = 0.099, p<0.05), UMA (r = 0.104, p<0.05), FM (r = 0.155, p<0.01), and FFM (r = 0.383, p<0.01) among the female Limboo individuals. The only negatively and significantly correlated variables with RAL were BAI (r = -0.246, p<0.01), and CRI (r = -0.367, p<0.01) among females of the present study. The only strong correlation observed was with LAL.

LAL like RAL was positively and significantly correlated with MUAC (r = 0.090, p<0.05), NC (r = 0.146, p<0.01), HC (r = 0.197, p<0.01), WC (r = 0.169, p<0.01), SH (r = 0.384, p<0.01), CI (r = 0.110, p<0.01), TUA (r = 0.102, p<0.05), UMA (r = 0.103, p<0.05), FM (r = 0.159, p<0.01) and FFM (r = 0.369, p<0.01) among the female Limboo individuals. The only negatively and significantly correlated variables with LAL were BAI (r = -0.254, p<0.01), and CRI (r = -0.380, p<0.01) among the females of the present study. The correlations observed were low.

The MUAC was positively and significantly correlated with NC (r = 0.698, p<0.01), WC (r= 0.694, p<0.01), HC (r= 0.747, p<0.01), SH (r= 0.216, p<0.01), TSF (r = 0.614, p<0.01), BSF (r= 0.622, p<0.01), SSF (r = 0.679, p<0.01), SISF (r = 0.519, p<0.01), BMI (r = 0.847, p<0.01), BAI (r= 0.662, p<0.01), WHtR (r = 0.665, p<0.01), WHR (r= 0.189, p<0.01), CI (r = 0.204, p<0.01), CRI (r= 0.131, p<0.01), TUA (r = 0.997, p<0.01), UMA(r = 0.988, p<0.01), UFA (r = 0.751, p<0.01), AFI (r = 0.373, p <0.01), PBF (r = 0.713, p<0.01), FM (r = 0.821, p<0.01), FFM (r = 0.744, p<0.01), FMI (r = 0.822, p<0.01) and FFMI (r = 0.768, p<0.01). All the correlation were strong except with SH, WHR, CI, CRI, and AFI.

The NC was positively and significantly correlated with WC (r = 0.696, p<0.01), HC (r= 0.675, p<0.01), SH (r = 0.271, p<0.01), TSF (r = 0.356, p<0.01), BSF (r = 0.516, p<0.01), SSF (r =0.607, p<0.01), SISF (r = 0.493, p<0.01), BMI (r = 0.781, p<0.01), BAI (r = 0.532, p<0.01), WHtR (r = 0.638, p<0.01), WHR (r = 0.275, p<0.01), CI (r = 0.263, p<0.01), TUA (r = 0.696, p<0.01), UMA (r = 0.702, p<0.01), UFA (r = 0.466, p<0.01), AFI (r = 0.170, p<0.01), PBF (r = 0.565, p<0.01), FM (r = 0.731, p<0.01), FFM (r = 0.784, p<0.01), FMI (r = 0.708, p<0.01) and FFMI (r = 0.755, p<0.01) among female Limboo individuals. Among them SH, WHR, CI, and AFI were weakly associated with NC.

The WC was positively and significantly correlated with HC (r = 0.743, p<0.01), SH (r = 0.191, p<0.01), TSF (r = 0.489, p<0.01), BSF (r = 0.625, p<0.01), SSF (r =0.671, p<0.01), SISF (r = 0.563, p<0.01), BMI (r= 0.822, p<0.01), BAI (r = 0.630, p<0.01), WHtR (r = 0.961, p<0.01), WHR (r = 0.621, p<0.01), CI (r = 0.760, p<0.01), TUA (r = 0.701, p<0.01), UMA (r = 0.684, p<0.01), UFA (r = 0.583, p<0.01), AFI (r = 0.320, p<0.01), PBF (r= 0.654, p<0.01), FM (r = 0.801, p<0.01), FFM (r = 0.753, p<0.01), FMI (r = 0.791, p<0.01), and FM (r = 0.751, p<0.01) among female Limboo individuals. The observed correlations were strong except with SH, TSF, AFI.

The HC was positively and significantly correlated with SH (r = 0.322, p<0.01), TSF (r = 0.570, p<0.01), BSF (r = 0.600, p<0.01), SSF (r =0.691, p<0.01), SISF (r = 0.591,p<0.01), BMI (r= 0.828, p<0.01), BAI (r = 0.832, p<0.01), WHtR (r = 0.672, p<0.01), CI (r = 0.275, p<0.01), TUA (r = 0.749, p<0.01), UMA (r = 0.725, p<0.01), UFA (r = 0.654, p<0.01), AFI (r = 0.407, p<0.01), PBF (r = 0.710, p<0.01), FM (r = 0.844, p<0.01), FFM (r = 0.789, p<0.01), FMI (r = 0.818, p<0.01) and FFMI (r = 0.736, p<0.01) among female Limboo individuals. The correlation observed were strong except with SH, CI, and AFI.

The SH was positively and significantly correlated with, TSF (r= 0.152, p<0.01), BSF (r = 0.215, p<0.01), SSF (r = 0.183, p<0.01), SISF (r = 0.223, p<0.01), BMI (r = 0.165, p<0.01), CRI (r = 0.509, p<0.01), TUA (r = 0.217, p<0.01), UMA (r = 0.213, p<0.01), UFA (r = 0.177,p<0.01), AFI (r = 0.107, p<0.05), PBF (r= 0.235, p<0.01), FM (r = 0.337, p<0.01), FFM (r = 0.423, p<0.01), FMI (r = 0.214, p<0.01) and FM (r = 0.099, p<0.05) among female Limboo individuals. The only strong correlation was observed with CRI.

The TSF was positively and significantly correlated with BSF (r = 0.598, p<0.01), SSF (r = 0.615, p<0.01), SISF (r = 0.520, p<0.01), BMI (r = 0.587, p<0.01), BAI (r = 0.519, p<0.01), WHtR (r = 0.475, p<0.01), WHR (r = 0.090, p<0.01), CI (r= 0.158, p<0.01), TUA (r = 0.612, p<0.01), UMA (r = 0.504, p<0.01), UFA (r= 0.975, p<0.01), AFI (r = 0.955, p<0.01), PBF (r = 0.800, p<0.01), FM (r = 0.735, p<0.01), FFM (r = 0.362, p<0.01), FMI (r = 0. 745, p<0.01) and FFMI (r = 0.365, p<0.01). The correlations observed were strong except with WHR and CI.

The BSF was positively and significantly correlated with SSF (r = 0.686, p<0.01), SISF (r = 0.625, p<0.01), BMI (r = 0.678,p<0.01), BAI (r = 0.543, p<0.01), WHtR (r = 0.609, p<0.01), WHR (r = 0.243,p<0.01), CI (r = 0.291, p<0.01), TUA (r = 0.629, p<0.01), UMA (r = 0.589, p<0.01), UFA (r = 0.650, p<0.01), AFI (r = 0.480, p<0.01), PBF (r = 0.790, p<0.01), FM (r = 0.786, p<0.01), FFM (r = 0.468, p<0.01), FMI (r = 0. 798, p<0.01), and FFMI (r = 0.482, p<0.01). Excluding WHR and CI, all correlations with BSF were strong.

The SSF was positively and significantly correlated with SISF (r = 0.690, p<0.01), BMI (r = 0.773, p<0.01), BAI (r = 0.649, p<0.01), WHtR (r = 0.661, p<0.01), WHR (r = 0.214, p<0.01), CI (r = 0.266, p<0.01), CRI (r = 0.168, p<0.01), TUA (r = 0.681, p<0.01), UMA (r = 0.644, p<0.01), UFA (r = 0.672, p<0.01), AFI (r = 0.484, p<0.01), PBF (r = 0.871, p<0.01), FM (r = 0.867, p<0.01), FFM (r = 0.536, p<0.01), FMI (r = 0. 885, p<0.01) and FFMI (r = 0.572, p<0.01). The correlations observed were strong except with WHR, CI, and CRI.

The SISF was positively and significantly correlated with BMI (r = 0.626, p<0.01), BAI (r = 0.529, p<0.01), WHtR (r = 0.542, p<0.01), WHR (r = 0.169, p<0.01), CI (r = 0.241, p<0.01), CRI (r = 0.172, p<0.01), TUA (r = 0.520, p<0.01), UMA (r = 0.484, p<0.01), UFA (r = 0.549, p<0.01), AFI (r = 0.436, p<0.01), PBF (r = 0.838, p<0.01), FM (r = 0.782, p<0.01), FFM (r = 0.397, p<0.01), FMI (r = 0. 792, p<0.01) and FFMI (r = 0.393, p<0.01). The correlations of SISF observed were strong except with WHR, CI, CRI, UMA, and AFI.

The BMI was positively and significantly correlated with BAI (r = 0.804, p<0.01), WHtR (r = 0.824, p<0.01), WHR (r = 0.291, p<0.01), CI (r = 0.283, p<0.01), CRI (r = 0.192, p<0.01), TUA (r = 0.850, p<0.01), UMA (r= 0.832, p<0.01), UFA (r = 0.696, p<0.01), AFI (r = 0.387, p<0.01), PBF (r =0.762, p<0.01), FM (r = 0.907, p<0.01), FFM (r = 0.838, p<0.01), FMI (r = 0.934, p<0.01) and FFMI (r = 0.941, p<0.01) among the female Limboo individuals. The correlation of BMI with WHR, CI, and AFI were observed to be low.

The BAI was positively and significantly correlated with CI (r = 0.242, p<0.01), CRI (r = 0.257, p<0.01), TUA (r = 0.659, p<0.01), UMA (r = 0.635, p<0.01), UFA (r = 0.586, p<0.01), AFI (r = 0.381, p<0.01), PBF (r = 0.655, p<0.01), FM (r = 0.683, p<0.01), FFM (r = 0.503, p<0.01), FMI (r = 0.769, p<0.01) and FFMI (r = 0.739, p<0.01) among the female Limboo individuals. The observed association of CI, CRI, and AFI with BAI were low.

The WHtR was positively and significantly correlated with WHR (r = 0.644, p<0.01), CI (r = 0.757, p<0.01), CRI (r = 0.121, p<0.01), TUA (r = 0.670, p<0.01), UMA (r = 0.653, p<0.01), UFA (r = 0.562, p<0.01), AFI (r = 0.314, p<0.01), PBF (r = 0.642, p<0.01), FM (r = 0.735, p<0.01), FFM (r = 0.626, p<0.01), FMI (r = 0.781, p<0.01) and FFMI (r = 0.765, p<0.01) among the female Limboo individuals. The observed correlations were strong except with CRI and AFI. Similarly, WHR was positively and significantly correlated with CI (r= 0.774, p<0.01), TUA (r = 0.197, p<0.01), UMA (r =0.198, p<0.01), UFA (r = 0.134, p<0.01), PBF (r = 0.175, p<0.01), FM (r = 0. 238, p<0.01), FFM (r = 0.233, p<0.01), FMI (r = 0.253, p<0.01) and FFMI (r = 0.290, p<0.01) among the female Limboo individuals. The only strong correlation was observed with CI another central obesity marker. The remaining correlation of CI with TUA (r = 0.212, p<0.01), UMA (r = 0.204, p<0.01), UFA (r = 0.191, p<0.01), AFI (r = 0.099, p<0.05), PBF (r = 0.247, p<0.01), FM (r = 0.294, p<0.01), FFM (r = 0.239, p<0.01), FMI (r = 0.293, p<0.01) and FFMI (r = 0.239, p<0.01) was observed low among the female Limboo individuals. As observed in preceding paragraphs WHR and CI were weakly correlated with skinfolds measurements like BSF, TSF, SSF, and SISF.

The TUA was positively and significantly correlated with UMA (r = 0.991, p<0.01), UFA (r = 0.754, p<0.01), AFI (r = 0.367, p<0.01), PBF (r = 0.706, p<0.01), FM (r = 0.826, p<0.01), FFM (r = 0.751, p<0.01), FMI (r = 0.825, p<0.01) and FFMI (r = 0.770, p<0.01). The negatively and significantly correlated variables with TUA were body density (r = -0.705, p<0.01), FFM (r = -0.640, p<0.01) and FFMI (r = -0.635, p<0.01). Further, UMA was positively and significantly correlated with UFA (r = 0.662, p<0.01), AFI (r = 0.367, p<0.01), PBF (r = 0.643, p<0.01), FM (r = 0.782, p<0.01), FFM (r = 0.759, p<0.01), FMI (r = 0.779, p<0.01) and FFM (r = 0.780, p<0.01). The correlations with TUA and UMA were strong except with AFI. The UFA was positively and significantly correlated with AFI (r = 0.867, p<0.01), PBF (r= 0.819,p<0.01), FM (r = 0.810,p<0.01), FFM (r = 0.491, p<0.01), FMI (r = 0.817, p<0.01) and FFMI (r = 0.497, p<0.01) among the female Limboo individuals. The correlations observed were strong with UFA. Furthermore, AFI was positively and significantly correlated with PBF (r = 0.707, p<0.01), FM (r = 0.573, p<0.01), FFM (r = 0.154, p<0.01), FMI (r = 0.587, p<0.01) and FFMI (r = 0.150, p<0.01), among the female Limboo individuals. The correlations were strong except with FFM and FFMI.

The PBF was positively and significantly correlated with FM (r = 0.916, p<0.01), FFM (r = 0.490, p<0.01), FMI (r = 0.934, p<0.01) and FFMI (r = 0.507, p<0.01). The correlations of FM with FFM (r = 0.775, p<0.01), FMI (r =0.979, p<0.01) and FFMI (r = 0.729, p<0.01) were positive and significant. The observed correlation of FFM with FMI (r = 0.701, p<0.01) and FFMI (r = 0.865, p<0.01) was positive and significant. The correlated of FMI with FFMI (r = 0.757, p<0.01) was positive and significant. The observed correlations were strong.

Table 3.6: Pearson correlation (r) between different anthropometric variables of male Limboo individuals

	Age	Height	Weight	Armspan	RAL	LAL	MUAC	NC	WC	HC	SH	TSF	BSF	SSF	SISF	BMI	BAI	WHtR	WHR	CI	CRI	TUA	UMA	UFA	AFI	PBF	FM	FFM	FMI	FFMI
Age	1																													
Height	-.130**	1																												
Weight	.156**	.411**	1																											
Armspan	-0.009	.788**	.392**	1																										
RAL	0.037	.794**	.341**	.900**	1																									
LAL	0.038	.787**	.343**	.910**	.977**	1																								
MUAC	.112*	.100*	.770**	.100*	0.083	.094*	1																							
NC	.144**	.197**	.740**	.181**	.149**	.165**	.636**	1																						
WC	.327**	.145**	.838**	.181**	.159**	.166**	.699**	.658**	1																					
HC	.164**	.330**	.860**	.319**	.280**	.277**	.681**	.651**	.765**	1																				
SH	-.114*	.783**	.453**	.540**	.516**	.499**	.170**	.258**	.198**	.386**	1																			
TSF	-0.049	0.019	.612**	0.014	-0.017	-0.013	.567**	.460**	.631**	.595**	0.074	1																		
BSF	0.041	0.075	.693**	0.063	0.033	0.034	.602**	.530**	.678**	.610**	.130**	.800**	1																	
SSF	.090*	0.044	.700**	0.01	-0.01	-0.007	.632**	.638**	.707**	.627**	.150**	.721**	.781**	1																
SISF	0.069	0.049	.675**	0.008	0	0.001	.627**	.574**	.694**	.616**	.135**	.770**	.765**	.778**	1															
BMI	.234**	-0.074	.876**	0.018	-0.044	-0.037	.789**	.706**	.838**	.769**	0.084	.661**	.723**	.747**	.713**	1														
BAI	.250**	-.495**	.456**	-.333**	-.375**	-.372**	.540**	.435**	.583**	.654**	-.272**	.532**	.500**	.539**	.522**	.764**	1													
WHtR	.370**	-.253**	.653**	-.134**	-.158**	-.148**	.640**	.563**	.920**	.616**	-.116**	.610**	.632**	.673**	.657**	.847**	.767**	1												
WHR	.319**	-.134**	.346**	-0.067	-0.058	-0.043	.328**	.301**	.700**	0.077	-.113*	.317**	.366**	.395**	.389**	.444**	.173**	.738**	1											
CI	.339**	-0.002	.172**	0.012	0.063	0.071	.151**	.161**	.649**	.216**	-0.048	.247**	.231**	.257**	.278**	.185**	.199**	.639**	.765**	1										
CRI	0.032	-.381**	0.037	-.408**	-.454**	-.469**	.095*	0.079	0.071	0.063	.276**	0.079	0.076	.154**	.123**	.240**	.361**	.220**	0.041	-0.066	1									
TUA	.117**	.098*	.769**	.097*	0.083	.093*	.998**	.626**	.700**	.677**	.169**	.569**	.609**	.635**	.628**	.788**	.538**	.642**	.332**	.156**	.098*	1								
UMA	.131**	.102*	.742**	.102*	.090*	.100*	.992**	.609**	.666**	.646**	.171**	.476**	.545**	.584**	.570**	.756**	.506**	.607**	.314**	.135**	.094*	.994**	1							
UFA	-0.016	0.037	.680**	0.034	0.005	0.01	.684**	.523**	.684**	.647**	.099*	.985**	.822**	.753**	.795**	.725**	.563**	.653**	.340**	.248**	0.087	.689**	.606**	1						
AFI	-0.087	-0.006	.499**	-0.012	-0.044	-0.043	.392**	.355**	.538**	.502**	0.041	.976**	.740**	.649**	.704**	.551**	.468**	.529**	.277**	.238**	0.068	.392**	.292**	.924**	1					
PBF	0.04	0.053	.746**	0.022	-0.004	0	.683**	.618**	.756**	.681**	.150**	.875**	.860**	.905**	.909**	.791**	.581**	.717**	.417**	.283**	.139**	.681**	.614**	.889**	.821**	1				
FM	.088*	.160**	.864**	.131**	.099*	.103*	.739**	.693**	.825**	.768**	.244**	.849**	.875**	.903**	.895**	.861**	.574**	.740**	.423**	.272**	.114*	.742**	.681**	.885**	.769**	.971**	1			
FFM	.178**	.523**	.935**	.513**	.457**	.458**	.667**	.654**	.713**	.786**	.528**	.346**	.453**	.445**	.411**	.745**	.300**	.487**	.236**	0.074	-0.024	.664**	.665**	.426**	.228**	.467**	.630**	1		
FMI	.102*	0.02	.814**	0.02	-0.015	-0.01	.735**	.671**	.812**	.732**	.135**	.859**	.879**	.910**	.899**	.884**	.654**	.784**	.443**	.271**	.167**	.737**	.676**	.892**	.782**	.978**	.987**	.561**	1	
FFMI	.303**	-.139**	.777**	0.014	-0.059	-0.053	.699**	.615**	.718**	.668**	0.029	.388**	.473**	.488**	.441**	.925**	.723**	.755**	.370**	0.083	.259**	.696**	.694**	.467**	.269**	.505**	.612**	.769**	.639**	1

** $p<0.01$; * $p<0.05$

Table 3.7: Pearson correlation (r) of different anthropometric variables of female Limboo individuals

	Age	Height	Weight	Armspan	RAL	LAL	MUAC	NC	WC	HC	SH	TSF	BSF	SSF	SISF	BMI	BAI	WHtR	WHR	CI	CRI	TUA	UMA	UFA	AFI	PBF	FM	FFM	FMI	FFMI
Age	1																													
Height	-.111*	1																												
Weight	.145**	.397**	1																											
Armspan	-0.021	.821**	.316**	1																										
RAL	0.032	.764**	.295**	.867**	1																									
LAL	0.02	.753**	.288**	.870**	.959**	1																								
MUAC	.131**	.128**	.827**	.090*	.089*	.090*	1																							
NC	.225**	.235**	.806**	.172**	.140**	.146**	.698**	1																						
WC	.206**	.179**	.823**	.150**	.154**	.169**	.694**	.696**	1																					
HC	.134**	.280**	.864**	.197**	.197**	.183**	.747**	.675**	.743**	1																				
SH	-.183**	.676**	.407**	.470**	.404**	.384**	.216**	.271**	.191**	.322**	1																			
TSF	-.144**	0.076	.567**	0.015	0.02	0.04	.614**	.356**	.489**	.570**	.152**	1																		
BSF	-0.036	0.083	.653**	-0.011	0.006	0.01	.622**	.516**	.625**	.600**	.215**	.598**	1																	
SSF	-0.014	0.06	.731**	-0.022	0.006	0.012	.679**	.607**	.671**	.691**	.183**	.615**	.686**	1																
SISF	-.107*	.101*	.610**	-0.015	-0.008	-0.002	.519**	.493**	.563**	.591**	.223**	.520**	.625**	.690**	1															
BMI	.205**	0.019	.923**	0.006	0.005	0	.847**	.781**	.822**	.828**	.165**	.587**	.678**	.773**	.626**	1														
BAI	.196**	-.296**	.622**	-.276**	-.246**	-.254**	.662**	.532**	.630**	.832**	-0.068	.519**	.543**	.649**	.529**	.804**	1													
WHtR	.239**	-.097*	.718**	-0.076	-0.057	-0.04	.665**	.638**	.961**	.672**	0.006	.475**	.609**	.661**	.542**	.824**	.719**	1												
WHR	.158**	-0.053	.250**	0	0.009	0.046	.189**	.275**	.621**	-0.049	-0.076	.090*	.243**	.214**	.169**	.291**	-0.031	.644**	1											
CI	.159**	0.052	.280**	0.058	0.079	.110*	.204**	.263**	.760**	.275**	-0.016	.158**	.291**	.266**	.241**	.283**	.242**	.757**	.774**	1										
CRI	-.106*	-.290**	0.064	-.350**	-.367**	-.380**	.131**	0.077	0.04	.090*	.509**	.108*	.183**	.168**	.172**	.192**	.257**	.121**	-0.036	-0.082	1									
TUA	.136**	.136**	.834**	.099*	.099*	.102*	.997**	.696**	.701**	.749**	.217**	.612**	.629**	.681**	.520**	.850**	.659**	.670**	.197**	.212**	.123**	1								
UMA	.169**	.135**	.817**	.105*	.104*	.103*	.988**	.702**	.684**	.725**	.213**	.504**	.589**	.644**	.484**	.832**	.635**	.653**	.198**	.204**	.118**	.991**	1							
UFA	-0.072	.101*	.678**	0.042	0.048	0.065	.751**	.466**	.583**	.654**	.177**	.975**	.650**	.672**	.549**	.696**	.586**	.562**	.134**	.191**	.111*	.754**	.662**	1						
AFI	-.235**	0.038	.369**	-0.021	-0.016	0.006	.373**	.170**	.320**	.407**	.107*	.955**	.480**	.484**	.436**	.387**	.381**	.314**	0.023	.099*	.094*	.367**	.247**	.867**	1					
PBF	-.136**	0.085	.729**	-0.031	-0.014	-0.008	.713**	.565**	.657**	.710**	.235**	.800**	.790**	.871**	.838**	.762**	.655**	.642**	.175**	.247**	.207**	.706**	.643**	.819**	.707**	1				
FM	0.016	.259**	.933**	.155**	.155**	.159**	.821**	.731**	.801**	.844**	.337**	.735**	.786**	.867**	.782**	.907**	.683**	.735**	.238**	.292**	.135**	.826**	.782**	.810**	.573**	.916**	1			
FFM	.240**	.473**	.951**	.420**	.383**	.369**	.744**	.784**	.753**	.789**	.423**	.362**	.468**	.536**	.397**	.838**	.503**	.626**	.233**	.239**	-0.004	.751**	.759**	.491**	.154**	.490**	.775**	1		
FMI	0.038	0.067	.880**	-0.003	0.007	0.011	.822**	.708**	.791**	.818**	.214**	.745**	.798**	.885**	.792**	.934**	.769**	.781**	.253**	.293**	.201**	.825**	.779**	.817**	.587**	.934**	.979**	.701**	1	
FFMI	.338**	-0.028	.851**	0.013	0.002	-0.01	.768**	.755**	.751**	.736**	.099*	.365**	.482**	.572**	.393**	.941**	.739**	.765**	.290**	.239**	.160**	.770**	.780**	.497**	.150**	.507**	.729**	.865**	.757**	1

** p<0.01; * p<0.05

3.2.7 LINEAR REGRESSION OF SEX ON ANTHROPOMETRIC AND BODY COMPOSITION VARIABLES AMONG THE LIMBOO INDIVIDUALS

The linear regression was conducted to assess the impact of various anthropometric and body composition variables and indices on sex. The linear regression was conducted on the entire sample (n=992) and finding is presented in Table 3.8. The sex coded as 1 for “female” and 2 for “male” were taken as dependent variables and anthropometric variables/indices as independent variables. The anthropometric variables/indices such as height, weight, arm span, RAL, LAL, NC, SH, CRI, TUA, UMA, FFM, FFMI has significant positive effect on sex of the studied population. The remaining variables/indices like WC, HC, TSF, BSF, SSF, SISF, BMI, BAI, WHtR, WHR, CI, UFA, AFI, BFMA, PBF, FM and FMI have significant negative effect on the sex of the studied individuals. This indicates clear sexual dimorphism in the anthropometric variables/indices in the present study. The PBF (R^2 = 0.572) explains more variation of sex followed by SH (R^2 = 0.505), height (R^2 = 0.481), FFM (R^2 = 0.490), arm span (R^2 = 0.464), among Limboo individuals. Similar corresponding trend was noticed with SEE.

3.2.8 LINEAR REGRESSION OF AGE ON ANTHROPOMETRIC AND BODY COMPOSITION VARIABLES AMONG THE LIMBOO INDIVIDUALS

To see the impact of various anthropometric variables/indices on age, linear regression was carried out with age as dependent variable and anthropometric variables/indices as independent variables among male and female Limboo individuals separately. The results are presented in Table 3.9 and 3.10. The variables with significant negative impact on the age of the male Limboo individuals were height and SH. Other variables like weight, arm span, MUAC, NC, WC, HC, BMI, BAI, WHtR, WHR, CI, TUA,UMA, BFMA and FMI has significant positive impact on age of the male Limboo individuals. The variable which explain more variation on age were WHtR (R^2 = 0.135), CI (R^2 = 0.113), WC (R^2 = 0.105) and WHR (R^2 = 0.100) based on adjusted R^2 however, proportion explain was very small. The same trend was found with SEE.

Table 3.8: Linear Regression of sex on anthropometric and body composition variables among the Limboo individuals

Variable	Intercept	B	p-value	R^2	SEE
Height	-5.490	0.045	< 0.01	0.481	0.360
Weight	0.648	0.016	< 0.01	0.098	0.478
Arm span	-4.482	0.038	< 0.01	0.464	0.366
RAL	-3.757	0.080	< 0.01	0.376	0.395
LAL	-3.785	0.081	< 0.01	0.383	0.393
MUAC	0.228	0.050	< 0.01	0.073	0.482
NC	-2.049	0.106	< 0.01	0.386	0.392
WC	2.261	-0.009	< 0.01	0.029	0.493
HC	2.403	-0.010	< 0.01	0.019	0.495
SH	-5.279	0.081	< 0.01	0.505	0.352
TSF	2.049	-0.062	< 0.01	0.257	0.431
BSF	1.904	-0.083	< 0.01	0.151	0.461
SSF	1.724	-0.020	< 0.01	0.031	0.493
SISF	1.836	-0.037	< 0.01	0.101	0.474
BMI	1.832	-0.015	< 0.01	0.010	0.498
BAI	3.303	-0.063	< 0.01	0.367	0.398
WHtR	3.228	-3.256	< 0.01	0.185	0.452
WHR	2.185	-0.746	< 0.01	0.011	0.498
CI	4.503	-2.374	< 0.01	0.171	0.455
CRI	-0.455	3.595	< 0.01	0.010	0.498
TUA	0.892	0.012	< 0.01	0.067	0.483
UMA	0.667	0.017	< 0.01	0.125	0.468
UFA	1.883	-0.107	< 0.01	0.155	0.460
AFI	2.228	-0.107	< 0.01	0.375	0.396
BFMA	1.103	-0.010	< 0.01	0.037	0.491
PBF	2.425	-0.050	< 0.01	0.572	0.327
FM	2.018	-0.051	< 0.01	0.260	0.430
FFM	-0.490	0.045	< 0.01	0.490	0.357
FMI	2.092	-0.135	< 0.01	0.373	0.396
FFMI	-0.348	0.100	< 0.01	0.200	0.440

The variables with significant positive impact on age of the female Limboo individuals were weight, RAL, MUAC, NC, WC, HC, BMI, BAI, WHtR, WHR, CI, TUA, UMA, BFMA, FFM and FFMI. The variables with significant negative impact on the age were height, armspan, SH, TSF, SISF, AFI and PBF among the female Limboo individuals. The associated R^2 values of these variables were below 0.056, impact were subtle. The observed trend was similar with SEE.

Table 3.9: Linear Regression of age on anthropometric and body composition variables among the Limboo male individuals

Variable	Intercept	B	p-value	R^2	SEE
Height	80.618	-0.281	< 0.01	0.015	12.672
Weight	22.955	0.064	< 0.01	0.022	12.625
Arm span	38.621	-0.017	ns	-0.002	12.780
RAL	25.127	0.157	ns	-0.001	12.772
LAL	24.958	0.160	ns	-0.001	12.772
MUAC	20.485	0.584	< 0.01	0.011	12.700
NC	8.114	0.787	< 0.01	0.019	12.646
WC	-9.162	0.562	< 0.01	0.105	12.078
HC	3.197	0.370	< 0.01	0.025	12.607
SH	76.454	-0.468	< 0.01	0.011	12.698
TSF	37.214	-0.211	ns	0.000	12.765
BSF	34.447	0.369	ns	0.000	12.770
SSF	33.036	0.259	ns	0.006	12.750
SISF	33.882	0.244	ns	0.003	12.750
BMI	14.519	0.945	< 0.01	0.053	12.424
BAI	9.056	1.037	< 0.01	0.061	12.374
WHtR	-13.918	98.913	< 0.01	0.135	11.874
WHR	-30.127	72.452	< 0.01	0.100	12.113
CI	-53.618	72.747	< 0.01	0.113	12.025
CRI	18.879	30.978	ns	-0.001	12.774
TUA	27.911	0.143	< 0.01	0.012	12.693
UMA	26.638	0.175	< 0.01	0.015	12.671
UFA	36.178	-0.141	ns	-0.002	12.779
AFI	38.774	-0.593	ns	0.006	12.732
BFMA	28.389	0.175	< 0.01	0.015	12.671
BD	81.936	-43.150	ns	0.000	12.771
PBF	34.479	0.101	ns	0.000	12.770
FM	33.643	0.279	ns	0.006	12.730
FFM	16.155	0.396	<0.001	0.000	12.769
FMI	33.287	0.830	< 0.05	0.008	12.714
FFMI	-3.288	2.005	< 0.001	0.090	12.182

ns = non-significant

Table 3.10: Linear Regression of age on anthropometric and body composition variables among the Limboo female individuals

Variable	Intercept	B	p-value	R^2	SEE
Height	72.954	-0.263	< 0.01	0.010	12.025
Weight	24.154	0.187	< 0.01	0.019	11.972
Armspan	39.594	-0.039	0.640	-0.002	12.097
RAL	25.812	0.126	0.483	-0.001	12.094
LAL	28.667	0.081	ns	-0.002	12.097
MUAC	19.685	0.570	< 0.01	0.015	11.996
NC	-4.650	1.218	< 0.01	0.049	11.789
WC	14.046	0.237	< 0.01	0.041	11.839
HC	15.703	0.201	< 0.01	0.016	11.992
SH	91.368	-0.714	< 0.01	0.031	11.897
TSF	38.453	-0.427	< 0.01	0.019	11.974
BSF	34.707	-0.164	ns	-0.001	12.092
SSF	34.217	-0.038	ns	-0.002	12.099
SISF	36.756	-0.285	< 0.01	0.010	12.030
BMI	18.730	0.648	< 0.01	0.040	11.843
BAI	17.025	0.529	< 0.01	0.036	11.866
WHtR	10.563	41.458	< 0.01	0.055	11.748
WHR	13.130	22.287	< 0.01	0.023	11.947
CI	7.596	20.102	< 0.01	0.023	11.947
CRI	76.966	-79.685	< 0.05	0.009	12.032
TUA	26.531	0.147	< 0.01	0.016	11.988
UMA	24.386	0.209	< 0.01	0.027	11.926
UFA	35.684	-0.446	ns	0.003	12.069
AFI	43.097	-1.089	< 0.01	0.053	11.761
BFMA	25.744	0.209	< 0.01	0.027	11.926
PBF	42.055	-0.343	< 0.01	0.017	11.987
FM	33.218	0.042	ns	-0.002	12.098
FFM	12.781	0.542	< 0.001	0.056	11.746
FMI	32.418	0.232	ns	-0.001	12.091
FFMI	-0.219	1.947	< 0.01	0.112	11.388

ns = non-significant

3.2.9 LINEAR REGRESSION OF BMI ON ANTHROPOMETRIC AND BODY COMPOSITION VARIABLES AMONG THE LIMBOO INDIVIDUALS

The linear regression was also conducted to observe the impact of other anthropometric variables/indices on BMI, for which BMI was taken as dependent variables and other anthropometric variables/indices as independent variables (Table

3.11 and 3.12). The variables with significant positive impact on BMI among the Limboo male individuals were weight, MUAC, NC, WC, HC, SH, TSF, BSF, SSF, SISF, BAI, WHtR, WHR, CI, TUA, UMA, UFA, AFI, BFMA, PBF, FM, FFM, FMI and FFMI. According to the relative R^2 values variables best explaining variation on BMI were FFMI (R^2 = 0.855), FMI (R^2 = 0.781), weight (R^2 = 0.766), FM (R^2 = 0.741), WHtR (R^2 = 0.717),WC (R^2 = 0.702), PBF (R^2 = 0.625), BD (R^2 = 0.624), MUAC (R^2 = 0.621), TUA(R^2 = 0.621), HC (R^2 = 0.590), BAI (R^2 = 0.582), UMA (R^2 = 0.571), BFMA (R^2 = 0.571), SSF (R^2 = 0.557), UFA (R^2 = 0.525), BSF (R^2 = 0.521), SISF (R^2 = 0.508), NC (R^2 = 0.498) and TSF (R^2 = 0.436) in descending order. The trend was similar for SEE. The values are presented in Table 3.11.

Among the female Limboo individuals the variables which has significant positive impact on BMI were weight, MUAC, NC, WC, HC, SH, TSF, BSF, SSF, SISF, BAI, WHtR, WHR, CI, TUA, UMA, UFA, AFI, BFMA, PBF, FM, FFM, FMI and FFMI. The values are presented in Table 3.12. Based on the relative R^2 values variables best explaining variation on BMI were FFMI (R^2 = 0.885), FMI (R^2 = 0.871), weight (R^2 = 0.852), FM (R^2 = 0.823), TUA (R^2 = 0.722), MUAC (R^2 = 0.717), BFMA (R^2 = 0.691), UMA (R^2 = 0.691), HC (R^2 = 0.684), WHtR (R^2 = 0.679), WC (R^2 = 0.675), NC (R^2 = 0.609), SSF (R^2 = 0.596), PBF (R^2 = 0.580), UFA (R^2 = 0.483), BAI (R^2 = 0.464) and BSF (R^2 = 0.459) in descending order. The trend also corresponds with the SEE.

Table 3.11: Linear Regression of BMI on anthropometric and body composition variables among the Limboo male individuals

Variable	Intercept	B	p-value	R^2	SEE
Height	28.855	-0.040	ns	0.004	3.082
Weight	4.583	0.313	< 0.01	0.766	1.53
Arm span	21.043	0.009	ns	0.002	3.169
RAL	25.660	-0.046	ns	0.000	3.166
LAL	25.138	-0.039	ns	0.001	3.167
MUAC	-4.152	1.017	< 0.01	0.621	1.948
NC	-11.060	0.954	< 0.01	0.498	2.244
WC	-6.083	0.357	< 0.01	0.702	1.728
HC	-15.321	0.430	< 0.01	0.590	2.027
SH	14.973	0.086	< 0.01	0.005	3.158
TSF	17.642	0.711	< 0.01	0.436	2.378
BSF	16.648	1.470	< 0.01	0.521	2.191
SSF	16.828	0.535	< 0.01	0.557	2.106
SISF	17.663	0.621	< 0.01	0.508	2.221
BAI	2.260	0.785	< 0.01	0.582	2.046
WHtR	-5.747	56.193	< 0.01	0.717	1.683
WHR	-0.283	25.030	< 0.01	0.196	2.840
CI	10.386	9.845	< 0.01	0.032	3.115
CRI	-9.167	58.033	< 0.01	0.056	3.077
TUA	9.357	0.239	< 0.01	0.621	0.195
UMA	9.384	0.251	< 0.01	0.571	2.073
UFA	17.880	1.610	< 0.01	0.525	2.182
AFI	17.780	0.930	< 0.01	0.302	2.645
BFMA	11.895	0.251	< 0.01	0.571	2.073
PBF	16.199	0.492	< 0.01	0.625	1.938
FM	17.337	0.674	< 0.01	0.741	1.612
FFM	2.096	0.411	< 0.001	0.554	2.114
FMI	17.131	1.786	< 0.01	0.781	1.483
FFMI	-7.132	1.520	< 0.001	0.855	1.206

ns = non-significant

Table 3.12: Linear Regression of BMI on anthropometric and body composition variables among the Limboo female individuals

Variable	Intercept	B	p-value	R^2	SEE
Height	21.057	0.014	ns	-0.002	3.831
Weight	3.817	0.377	< 0.01	0.852	1.472
Arm span	22.718	0.003	ns	-0.002	3.832
RAL	22.845	0.006	ns	-0.002	3.832
LAL	23.200	0.000	ns	-0.002	3.832
MUAC	-5.711	1.171	< 0.01	0.717	2.037
NC	-18.981	1.338	< 0.01	0.609	2.392
WC	-1.655	0.299	< 0.01	0.675	2.180
HC	-12.233	0.394	< 0.01	0.684	2.150
SH	6.672	0.205	< 0.01	0.025	3.779
TSF	17.132	0.553	< 0.01	0.343	3.102
BSF	17.514	0.305	< 0.01	0.459	2.816
SSF	15.196	0.658	< 0.01	0.596	2.432
SISF	17.664	0.526	< 0.01	0.391	2.987
BAI	1.442	0.689	< 0.01	0.646	2.277
WHtR	-2.094	45.226	< 0.01	0.679	2.169
WHR	11.231	12.940	< 0.01	0.083	3.666
CI	8.467	11.327	< 0.01	0.078	3.675
CRI	-1.519	45.598	< 0.01	0.035	3.761
TUA	8.858	0.292	< 0.01	0.722	2.019
UMA	8.593	0.326	< 0.01	0.691	2.128
UFA	17.270	1.373	< 0.01	0.483	2.751
AFI	18.334	0.568	< 0.01	0.148	3.533
BFMA	10.711	0.326	< 0.01	0.691	2.128
PBF	8.492	0.608	< 0.01	0.580	2.480
FM	13.565	0.754	< 0.01	0.823	1.612
FFM	0.019	0.599	< 0.001	0.701	2.002
FMI	12.848	1.800	< 0.01	0.871	1.372
FFMI	-6.746	1.716	< 0.001	0.885	1.206

3.2.10 LINEAR REGRESSION OF HEIGHT ON THE VARIOUS ANTHROPOMETRIC VARIABLES OF LIMBOO INDIVIDUALS

The linear regression was conducted to estimate the height from various anthropometric variables and to find the best predictor of the height. The result of the linear regression is presented in Table 3.13 and 3.14. The height of individuals was taken as dependent variables and other anthropometric variables as independent variables. The variables taken were significantly and positively associated with height except for TSF, BSF, SSF, SISF measurement among the male Limboo individuals (Table 3.13). Among these variables the best predictor of height were right arm length (R^2 = 0.62), left arm length (R^2 = 0.61), arm span (R^2 = 0.62) and SH (R^2 = 0.61). The trend also corresponds with the SEE.

Among the female Limboo individuals' variables taken as independent variables were significantly and positively associated with the height except for TSF, BSF and SSF (Table 3.14). The best predictors of height based on R^2 among these variables were arm span (R^2 = 0.67), right arm length (R^2 = 0.58), left arm length (R^2 = 0.56) and sitting height (R^2 = 0.45), which is also supported by SEE.

Further, linear regression was carried out for sex combined (male + female) Limboo individuals with height as dependent variables and other anthropometric variables as independent variables. The result is presented in Table 3.15. Linear anthropometric variables like arm span (R^2 = 0.80), RAL (R^2 = 0.75), LAL (R^2 = 0.75), SH (R^2 = 0.75) were the best predictors of height which is supported by both R^2 and SEE among Limboo individuals of present study.

Table 3.13: Linear regression equation for height (cm) estimation from the various anthropometric variables of male Limboo individuals

Variable	Intercept	B	p-value	R^2	SEE
Weight	143.787	0.274	< 0.01	0.168	5.373
Arm span	43.446	4.077	< 0.01	0.621	3.627
RAL	54.054	1.556	< 0.01	0.629	3.587
LAL	54.706	1.551	< 0.01	0.619	3.633
MUAC	153.136	0.240	< 0.05	0.008	5.865
NC	142.045	0.494	< 0.01	0.037	5.780
WC	150.242	0.115	< 0.01	0.019	5.833
HC	129.265	0.343	< 0.01	0.107	5.565
SH	29.949	1.490	< 0.01	0.613	3.664
TSF	159.179	0.037	ns	-0.002	5.894
BSF	158.310	0.283	ns	0.004	5.879
SSF	158.814	0.059	ns	0.000	5.889
SISF	158.813	0.080	ns	0.000	5.888

ns = non-significant

Table 3.14: Linear regression equation for height (cm) estimation from the various anthropometric variables of female Limboo individuals

Variable	Intercept	B	p-value	R^2	SEE
Weight	137.681	0.216	< 0.01	0.156	4.696
Arm span	52.477	0.639	< 0.01	0.674	2.912
RAL	67.452	1.291	< 0.01	0.583	3.299
LAL	68.605	1.277	< 0.01	0.566	3.368
MUAC	142.995	0.235	< 0.01	0.014	5.074
NC	131.870	0.537	< 0.01	0.053	4.973
WC	141.601	0.087	< 0.01	0.030	5.034
HC	132.781	0.178	< 0.01	0.077	4.911
SH	58.625	1.118	< 0.01	0.455	3.771
TSF	147.758	0.096	ns	0.004	5.101
BSF	147.882	0.160	ns	0.005	5.098
SSF	147.975	0.069	ns	0.002	5.107
SISF	147.616	0.113	< 0.05	0.008	5.090

ns = non-significant

Table 3.15: Linear regression equation for height (cm) estimation from the various anthropometric variables of sex (female + male) combined Limboo individuals

Variable	Intercept	B	p-value	R^2	SEE
Weight	133.045	0.388	< 0.01	0.234	6.701
Arm span	33.926	0.766	< 0.01	0.801	3.412
RAL	40.278	1.741	< 0.01	0.753	3.804
LAL	41.261	1.732	< 0.01	0.747	3.847
MUAC	135.006	0.751	< 0.01	0.070	7.381
NC	105.900	1.446	< 0.01	0.304	6.385
WC	156.602	-0.006	ns	-0.001	7.659
HC	143.422	0.120	< 0.01	0.011	7.612
SH	28.111	1.504	< 0.01	0.746	3.857
TSF	159.455	-0.599	< 0.01	0.103	7.250
BSF	157.621	-0.716	< 0.01	0.048	7.471
SSF	155.796	-0.147	ns	0.007	7.630
SISF	156.866	0.300	< 0.05	0.028	7.547

ns = non-significant

3.2.11 STEP-WISE MULTIPLE LINEAR REGRESSION OF HEIGHT ON VARIOUS ANTHROPOMETRIC VARIABLES AMONG LIMBOO INDIVIDUALS

The step-wise multiple linear regression equations for height estimation were constructed on the weight, arm span, RAL, LAL, MUAC, NC, WC, HC, and SH. Since the variables like TSF, BSF, SSF, SISF were not significant predictor of height on simple linear regression as a result not considered for step-wise multiple linear. Results are presented in Table 3.16 and 3.17. Among the male Limboo individuals step-wise multiple linear regression yield six best fit models for estimation of height from RAL, SH, arm span, WC, weight, LAL, and MUAC. The prediction strength based on R^2 value increases with the addition of variables in the model such as 1st (R^2 = 0.82), 2nd (R^2 = 0.82), 3rd (R^2 = 0.83), 4th (R^2 = 0.83), 5th (R^2 = 0.83) and 6th (R^2 = 0.83). The stated strength of models for height estimation were also supported the SEE.

Similarly among the female Limboo individuals there were five best fit models (Table 3.17). The models are constructed based on arm span, RAL, weight, MUAC and WC. Prediction strength of the models increases with the addition of variables in the model i.e. 1st (R^2 = 0.78), 2nd (R^2 = 0.79), 3rd (R^2 = 0.79), 4th (R^2 = 0.80) and 5th (R^2 = 0.80) which is also supported by SEE.

Table 3.16: Step-wise multiple linear regression equation for height estimation from various anthropometric variables of male Limboo individuals

Model No.	Variable	Intercept	B	p-value	R^2	SEE
1	RAL	4.697	1.041	< 0.01	0.820	2.500
	SH		0.969	< 0.01		
2	RAL	1.308	0.721	< 0.01	0.826	2.455
	SH		0.931	< 0.01		
	Arm span		0.174	< 0.01		
3	RAL	2.470	0.717	< 0.01	0.828	2.442
	SH		0.944	< 0.01		
	Arm span		0.180	< 0.01		
	WC		-0.038	< 0.01		
4	RAL	10.422	0.735	< 0.01	0.830	2.425
	SH		0.892	< 0.01		
	Arm span		0.159	< 0.01		
	WC		-0.109	< 0.01		
	Weight		0.079	< 0.01		
5	RAL	10.499	0.349	< 0.05	0.832	2.411
	SH		0.902	< 0.01		
	Arm span		0.122	< 0.01		
	WC		-0.112	< 0.01		
	Weight		0.080	< 0.01		
	LAL		0.465	< 0.01		
6	RAL	16.088	0.327	ns	0.834	2.401
	SH		0.882	< 0.01		
	Arm span		0.106	< 0.01		
	WC		-0.112	< 0.01		
	Weight		0.123	< 0.01		
	LAL		0.498	< 0.01		
	MUAC		-0.172	< 0.01		

ns = non-significant

Table 3.17: Step-wise multiple linear regression equation for height (cm) estimation from various anthropometric variables of female Limboo individuals

Model No.	Variable	Intercept	B	p-value	R^2	SEE
1	Arm span	23.302	0.503	< 0.01	0.782	2.919
	SH		0.616	< 0.01		
2	Arm span	22.209	0.357	< 0.01	0.793	2.389
	SH		0.617	< 0.01		
	RAL		0.364	< 0.01		
3	Arm span	23.814	0.354	< 0.01	0.794	2.320
	SH		0.592	< 0.01		
	RAL		0.357	< 0.01		
	Weight		0.025	< 0.05		
4	Arm span	32.181	0.337	< 0.01	0.802	2.276
	SH		0.570	< 0.01		
	RAL		0.347	< 0.01		
	Weight		0.108	< 0.01		
	MUAC		-0.312	< 0.01		
5	Arm span	36.797	0.330	< 0.01	0.804	2.260
	SH		0.545	< 0.01		
	LAL		0.350	< 0.01		
	Weight		0.162	< 0.01		
	MUAC		-0.322	< 0.01		
	WC		-0.0.50	< 0.01		

3.2.12 ASSESSMENT OF NUTRITIONAL STATUS USING BMI AMONG THE LIMBOO INDIVIDUALS

In the present study assessment of nutritional status was carried using BMI classification recommended by WHO (1995) and WHO (2000). The former is known as traditional classification and later was specifically recommended for population of Asia-Pacific region. The results obtained using both classifications are presented below in details.

3.2.12.1 Nutritional status of Limboo adults based on BMI classification of WHO (1995)

The prevalence of CED, overweight and obesity based on WHO (1995) classification is presented in Table 3.18. The combined (CED I, CED II and CED III) prevalence of underweight (BMI < 18.5 kg/m2) among the male and female Limboo individuals was 34 (6.85%) and 41 (8.27%), respectively. The overall underweight prevalence was 75 (7.56 %). Specifically, the prevalence of CED I, CED II and CED III was 61 (6.15%), 11 (1.11%) and 3 (0.30%), respectively among the Limboo individuals of the present study. The overall distribution of CED grades, overweight and obesity is presented in Figure 3.23. Among them more than half were identified as normal based on WHO (1995) criteria i.e. 665 (67.04%) individuals. Table 3.18 also depicts the sex wise distribution of different grades of CED, overweight and obesity of the present study. The CED I was found among the 29 (5.85%) male and 32 (6.45%) female Limboo individuals. The prevalence of CED II was 3 (0.60%) and 8 (1.61%) among the male and female individuals respectively. Further, the prevalence of CED III was 2 (0.40%) among males and 1 (0.20%) among females in the present study. The combined (CED I, CED II and CED III) prevalence of underweight (BMI < 18.5 kg/m^2) among Limboo individuals was independent of sex (χ^2 –value 0.707; d.f. 1; $p > 0.05$).The sex difference in the prevalence of CED I (χ^2 – value 0.157; d.f.1; $p> 0.05$), CED II (χ^2 – value 2.29; d.f.1; $p> 0.05$) and CED III (χ^2 – value 2.68; d.f.1; $p> 0.05$) were statistically non-significant.

Table 3.18: Prevalence of underweight, overweight and obesity using WHO (1995) classification among the Limboo individuals

BMI	Male (n = 496)	Female (n = 496)	Total (n = 992)
Normal	360 (72.58)	305 (61.49)	667 (67.24)
CED I	29 (5.85)	32 (6.45)	61 (6.15)
CED II	3 (0.60)	8 (1.61)	11 (1.11)
CED III	2(0.40)	1 (0.20)	3 (0.30)
CED Combined	34 (6.85)	41 (8.27)	75 (7.56)
Overweight	91 (18.35)	121 (24.40)	212 (21.37)
Obese	11 (2.23)	29 (5.85)	40 (4.03)

Figures in the parentheses are percentage

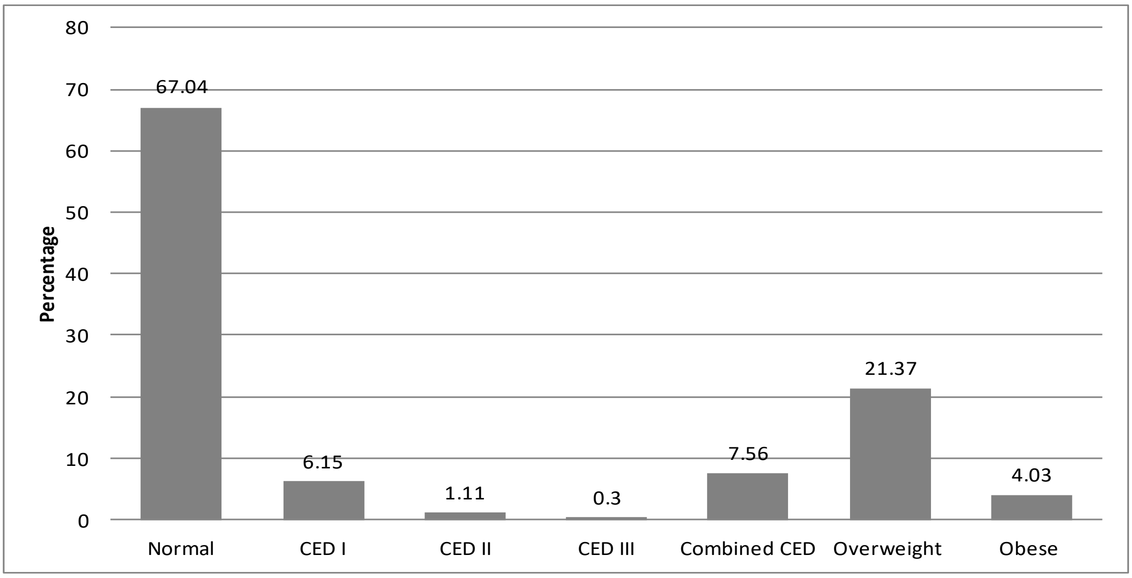


Figure 3.23: The overall prevalence of underweight, overweight, and obesity using WHO (1995) classification among the Limboo individuals.

The overall 212 (21.37%) and 40 (4.03%) individuals, was observed overweight and obese, respectively in the present study (Table 3.18). The observed sex specific prevalence of overweight was 91 (18.35%) male and 121 (24.40%) female Limboo individuals in the present study. The sex differences on the prevalence of overweight among the Limboo individuals were significant (χ^2 – value 5.79; d.f.1; $p< 0.05$). The prevalence of obesity among male individuals was 2.23% and among females was 5.85% in the present study. The prevalence of obesity between sexes of the present study was statistically significant (χ^2 – value 10.95; d.f.1; $p< 0.05$). The sex wise distribution of different grades of CED, overweight and obesity is also presented in the Figure 3.24.

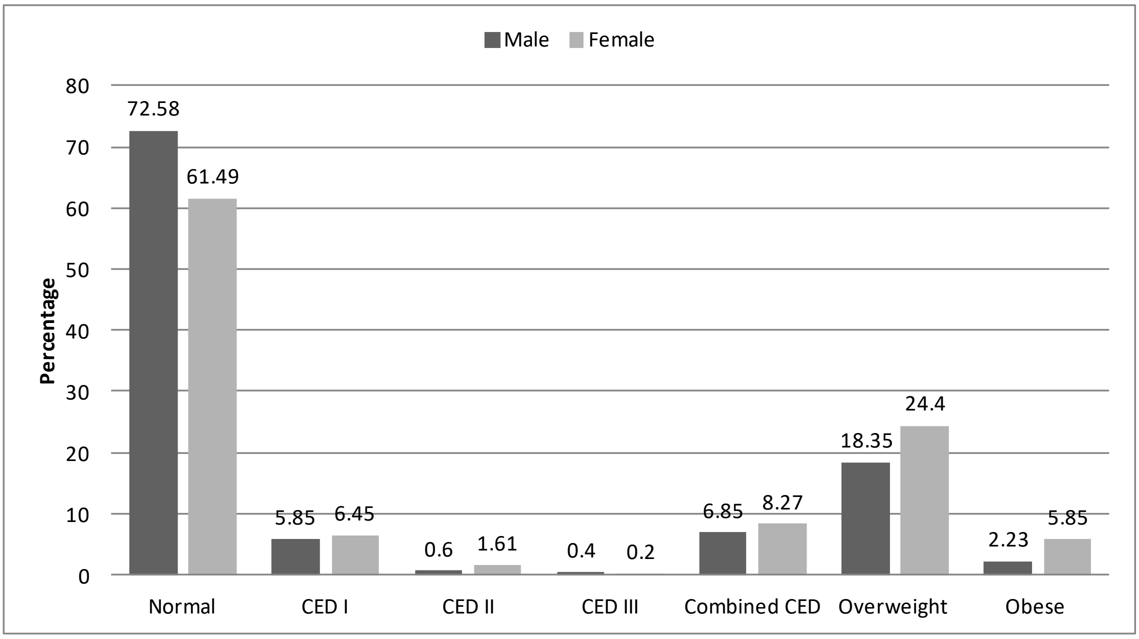


Figure 3.24: Sex specific prevalence of CED, overweight and obesity using WHO (1995) classification among the Limboo individuals.

Table 3.19: Age group wise prevalence of CED, overweight, and obesity using WHO (1995) classification among Limboo individuals

BMI Class	18-29 years		30-49 years		50-64 years	
	Male	Female	Male	Female	Male	Female
Normal	151 (79.89)	151 (69.91)	140 (64.85)	112 (54.63)	69 (75.82)	42 (56.00)
CED I	16 (8.47)	22 (10.19)	10 (4.63)	4 (1.95)	3 (3.30)	6 (8.00)
CED II	1(0.53)	6 (2.78)	2 (0.93)	1 (0.49)	0 (0.00)	1 (1.33)
CED III	0 (0.00)	0 (0.00)	1 (0.46)	0 (0.00)	1 (1.10)	1 (1.33)
CED (all)	17 (8.99)	28 (12.96)	13 (6.02)	5 (2.44)	4 (4.40)	8 (10.67)
Overweig ht	20 (10.58)	31 (14.35)	56 (25.93)	72 (35.12)	15 (16.48)	18 (24.00)
Obese	1 (0.53)	6 (2.78)	7 (3.24)	16 (7.80)	3 (3.30)	7 (9.33)
Total	189 (100)	216 (100)	216 (100)	205 (100)	91 (100)	75 (100)

Figures in the parentheses are percentage

The age group for the present study was 18-29 years, 30-49 years and 50-64 years. The overall age specific prevalence of underweight was high among female Limboo individuals of 18-29 years (12.96%) and 50-64 years (10.67%). In the age group 30-49 years, males (6.02%) were more undernourished than females (2.44%). The sex differences within each of the age group were found to be non-significant for underweight. However, the prevalence of prevalence of underweight was significant between the three age group (χ^2 –value 13.832; d.f. 2; $p < 0.01$). Details are presented in Table 3.19.

Further, prevalence of CED I was higher in the age group 18-29 years with 16 (8.47%) male and 22 (10.19%) female Limboo individuals. The prevalence of CED II was 1 (0.53%) among males and 6 (2.78%) among females. However, CED III was absent (0.0%) in both the sexes. In the middle age group i.e. 30-49 years, the prevalence of CED I was 10 (4.63%) among males and 4 (1.95%) among females. The prevalence of CED II was 2 (0.93%) and 1 (0.49%) among the Limboo male and female individuals respectively. Similarly, CED III was found among 1 (0.46%) male and absent (0.0%) among females of this age group. Among the 50-64 years individuals, 3 (3.30%) and 6 (8.00%), male and female individuals was observed with CED I, respectively. In the same age group lower prevalence of CED II was noted among males (0.00%) and females (1.33%). Similarly the prevalence of CED III was low in this age group (males: 1.10% and females: 1.33%).

The age group 18-29 years consists of 20 (10.58%) male and 31 (14.35%) female overweight individuals. The prevalence of overweight was high among the 30-49 years middle age Limboo individuals comprised of 56 (25.93%) males and 72 (35.12%) females. Similarly, prevalence of overweight among the old adults was 15 (16.48%) males and 18 (24.00%) females. On the other hand prevalence of obesity was relatively lower with 1 (0.53%) males and 6 (2.78%) females affected in the age group 18-29 years followed by 7 (3.24%) males and 16 (7.80%) females among the

30-49 years age group adults. Finally age group 50-64 years consists of 3 (3.30%) males and 7 (9.33%) females individuals with obesity.

The details are presented in Table 3.19 and supplemented with bar diagram (Figure 3.25). The sex difference in the prevalence of CED I, CED II, CED III, overweight and obesity across all age group were not significant except for overweight (χ^2-value 0.040;d.f.1;p>0.05) and obese (χ^2-value 0.010;d.f.1;p>0.05) 30-49 years individuals. Remaining χ^2-values are not presented here.

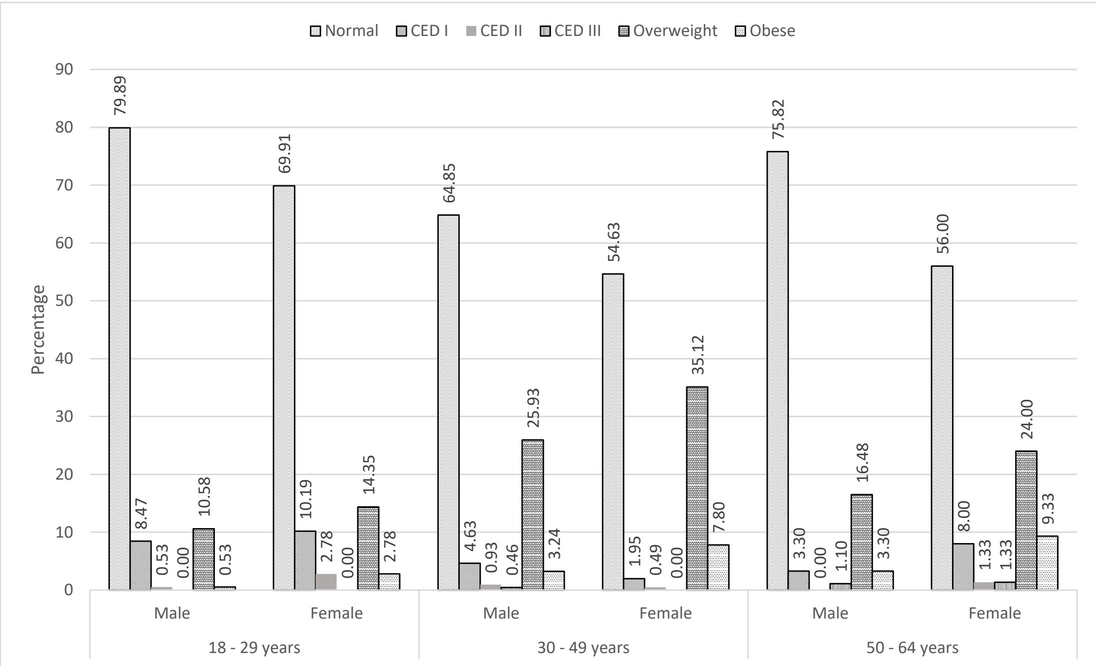


Figure 3.25: Distribution of age group wise prevalence of underweight, overweight, and obese using WHO (1995) classification among the Limboo individuals.

3.2.12.2 Nutritional status of Limboo individuals based on BMI criteria of WHO (2000).

The prevalence of overweight according this criterion was 17.14% each for male and female Limboo individuals of the present study (Table 3.20). The prevalence of overweight irrespective of sex was also same. The obesity category was further divided into obese I and obese II, which was observed among 214 (21.57%) and 39 (3.93%) individuals, respectively irrespective of sex. The sex specific prevalence of obesity I was 18.75% and 24.40%, among male and female individuals, respectively in the present study. Similarly the prevalence of obese II was 10 (2.02%) among male and 29 (5.85%) among female Limboo individuals of the present study.

The chance of falling under the normal range of WHO (2000) classification was associated with sex of the individuals in the present study (χ^2 –value 11.758; d.f. 1; $p < 0.01$). The normal range is also regarded as increasing but acceptable risk in this classification by Yajnik and Yudkin (2004) and association of average risk co-morbidities by WHO (2000).The occurrence of overweight was independent of sex (χ^2 –value 0.000; d.f. 1; $p > 0.05$). Further, significant association of sex with prevalence of obese I (χ2 –value 4.671; d.f. 1; $p < 0.05$) and obese II (χ^2 –value 9.635; d.f. 1; $p < 0.05$) was observed in the present study.

Table 3.20: Prevalence of undernutrition, overweight and obesity using WHO (2000) classification among the Limboo individuals of Sikkim

BMI class	Male	Female	Total
Normal	274(55.24)	220 (44.35)	494 (49.80)
Overweight	85 (17.14)	85 (17.14)	170 (17.14)
Obese I	93(18.75)	121 (24.40)	214 (21.57)
Obese II	10 (2.02)	29 (5.85)	39 (3.93)
Total	496	496	992

Figures in the parentheses are percentage

More males were under the normal category in each of these age groups 18-29 years (68.78% vs. 52.31%), 30-49 years (43.52% vs. 37.07%), and 50-64 years (54.95% vs. 41.33%) as presented in Table 3.21. The sex difference in the individuals falling under the normal category was only significant for age group 50-64 years (χ^2 –value 11.391; d.f.1; $p<0.01$). The females (17.59%) of age group 18-29 years were overweight than their male (10.58%) counterparts in the present study which was not significant. However, the prevalence of overweight was high among males of age group 30-49 years (21.30 %) and 50-64 years (17.56 %) compared to their female counterparts (20.88 % and 14.67 %). In the prevalence of overweight, the significant sex difference was only observed in age group 50-64 years (χ^2 –value 4.038; d.f. 1; p < 0.05). The rate of obese I was high among females Limboo individuals of different age group compared to males counterparts. The highest prevalence (35.12%) was found among females of age group 30-49 years. The prevalence of obese I across the age group was independent of sex. Similarly, more females were observed to be obese II compared to males in each of the age groups such as 18-29 years (males: 0.53% vs. females: 2.78%), 30-49 years (males: 2.78% vs. females: 7.80%), and 50-64 years (males: 3.30% vs. females: 9.33%) among the Limboo individuals of the present study. The sex difference in the prevalence of obese II was only observed in 30-49 years (χ^2 –value 5.367; d.f. 1; p < 0.05).

Table 3.21: Age group specific prevalence of overweight, obese I and obese II using WHO (2000) classification among Limboo individuals

BMI class	18-29 years		30-49 years		50-64 years	
	Male	Female	Male	Female	Male	Female
Normal	130 (68.78)	113 (52.31)	94 (43.52)	76 (37.07)	50 (54.95)	31 (41.33)
Overweight	20 (10.58)	38 (17.59)	46 (21.30)	36 (17.56)	19 (20.88)	11 (14.67)
Obese I	21 (11.11)	31 (14.35)	57 (26.39)	72 (35.12)	15 (16.48)	18 (24.00)
Obese II	1 (0.53)	6 (2.78)	6 (2.78)	16 (7.80)	3 (3.30)	7 (9.33)
Total	189 (100)	216 (100)	216 (100)	205 (100)	91 (100)	75 (100)

Figures in the parentheses are percentage

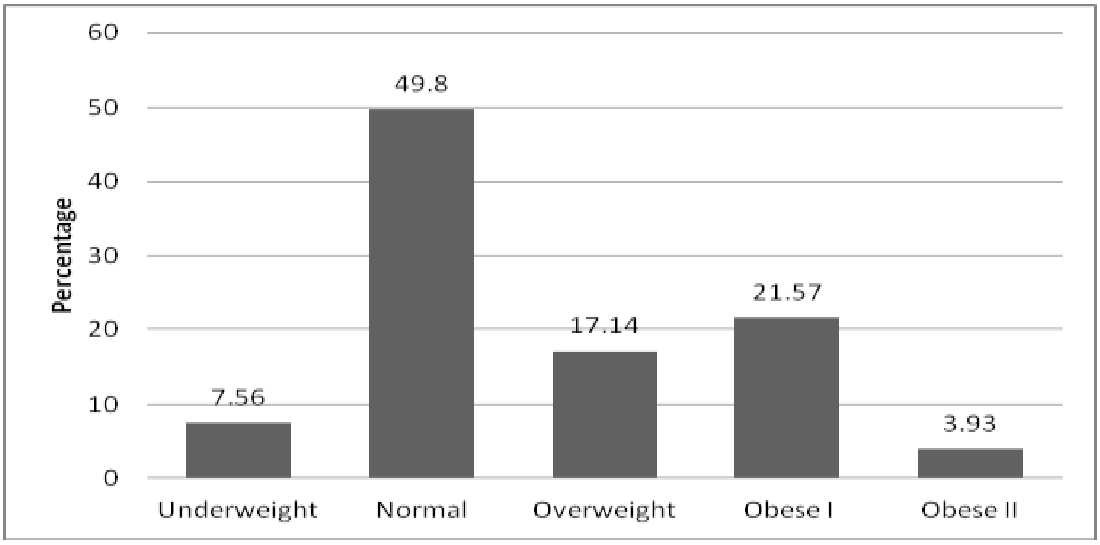


Figure 3.26: Overall prevalence of underweight, overweight, obese I, and obese II based using WHO (2000) classification among the Limboo individuals.

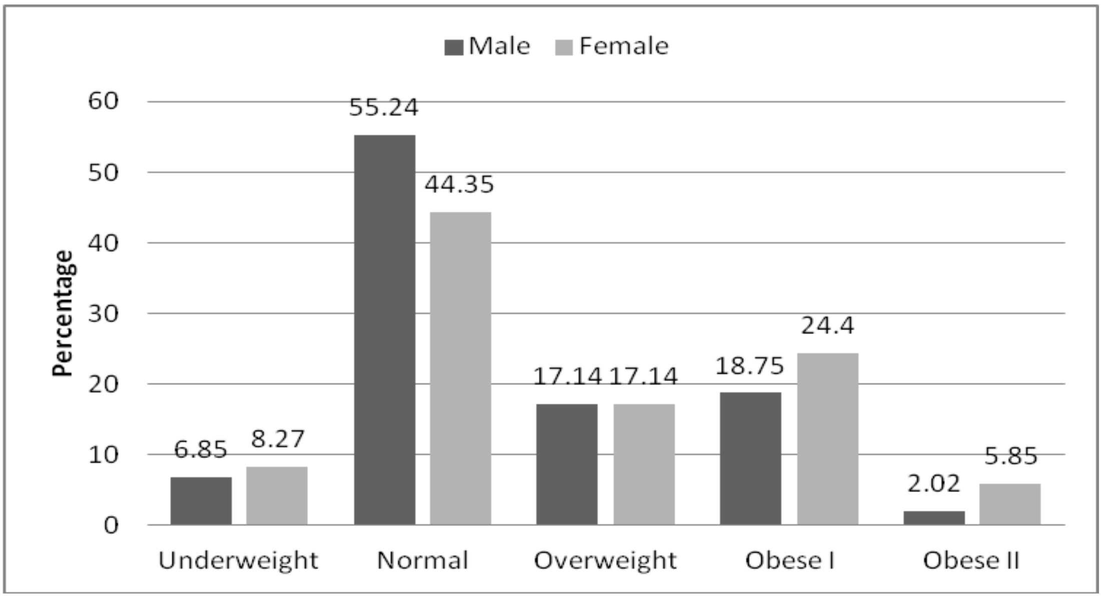


Figure 3.27: Sex specific prevalence of underweight, overweight, obese I, and obese II using WHO (2000) classification among the Limboo individuals.

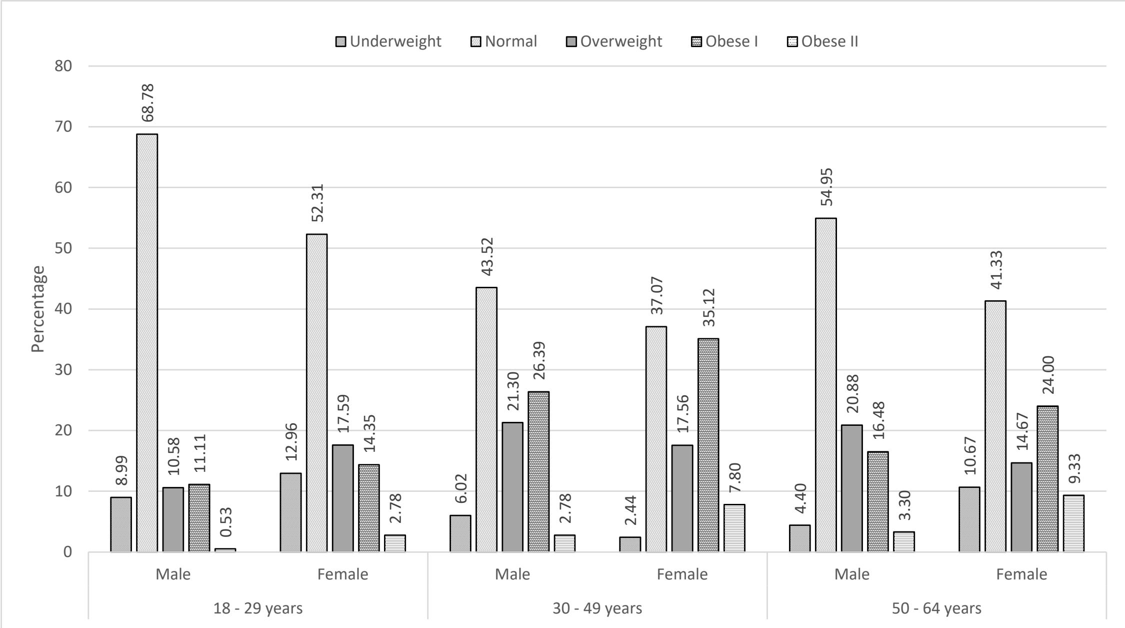


Figure 3.28: Age specific prevalence of undernutrition overweight and obesity using WHO (2000) classification among Limboo individuals.

The present study utilised χ^2 test to assess association of age with the prevalence of normal, overweight, obese I, and obese II among the male and female Limboo individuals. The age difference was noted significant in normal category Asia-Pacific BMI criteria (χ^2 –value 31.865; d.f.2; p<0.01). There was no association of age with the prevalence of overweight. However, significant age difference was observed in the prevalence of obese I (χ^2 –value 39.003; d.f.2; p<0.01) and obese II (χ^2 –value 8.996; d.f.2; p<0.01) among Limboo individual of the present study.

3.2.13 ASSESSMENT OF UNDERNUTRITION USING MUAC AMONG LIMBOO INDIVIDUALS

Table 3.22 shows the prevalence of undernutrition base on MUAC cut-offs given by James et al. (1994). The prevalence of undernutrition was high among females (13.91%) compared to males (6.45%) of the present study. The sex difference on the prevalence of MUAC based undernutrition was statistically significant (χ^2 –value 15.091; d.f.1; p<0.05). The overall prevalence of MUAC based undernutrition was 101 (10.18%) among the population of present study. This is also depicted in Figure 3.29.

Table 3.22: Prevalence of undernutrition using MUAC among the Limboo individuals

Sex	N	Undernutrition	Normal
Male	496	32 (6.45)	464 (93.55)
Female	496	69 (13.91)	427 (86.09)
Total	992	101 (10.18)	891 (89.82)

Figures in the parentheses are percentage

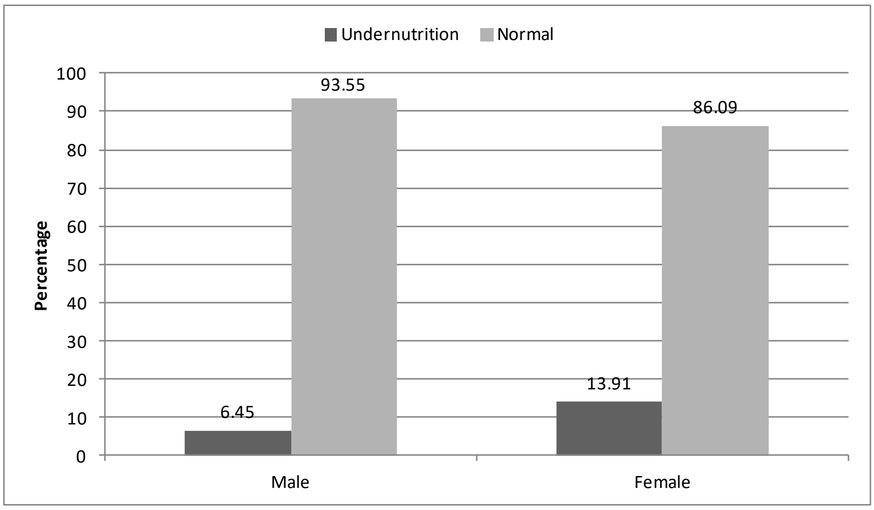


Figure 3.29: Sex specific distribution of undernutrition using MUAC among the Limboo individuals.

Table 3.23: Age specific prevalence of underweight using MUAC among the Limboo individuals

MUAC class	18-29 years		30-49 years		50-64 years	
	Male	Female	Male	Female	Male	Female
Underweight	13 (7.39)	39 (22.03)	10 (4.85)	12 (6.22)	9 (10.98)	18 (31.58)
Normal	176 (93.12)	177 (81.94)	206 (95.37)	193 (94.15)	82 (90.11)	57 (76.00)
N	189 (100)	216 (100)	216 (100)	205 (100)	91 (100)	75 (100)

Figures in the parentheses are percentage

The age specific undernutrition identified using MUAC showed high prevalence among females of 50-64 years (31.58%) followed by females of 18-29 years (22.03%) and then 30-49 years females (6.22%). Similarly, among men 50-64 years (10.98%) was more undernourished followed by females of 18-29 years (7.39%) and then 30-49 years females (4.85%). Sex specific χ^2 test within age group revealed significant difference in age group 18-29 years (χ^2 – value 11.253; d.f.1; p< 0.001) and age group 50-64 years (χ^2 – value 6.010; d.f.1; p< 0.05). These values are presented in Table 3.23.

Table 3.24: Prevalence of undernutrition using combination of BMI and MUAC among the Limboo individuals

Sex	MUAC	Norma -l	CED I	CED II	CED III	Over-weight	Obese	Total
Male	< 23 cm	15 (3.02)	14 (2.82)	2 (0.40)	1 (0.20)	0 (0.00)	0 (0.00)	32 (6.45)
	> 23 cm	345 (69.56)	15 (3.02)	1 (0.20)	1 (0.20)	91 (18.35)	9 (1.81)	464 (93.55)
	Total	360 (72.58)	29 (5.85)	3 (0.60)	2 (0.40)	91 (18.35)	9 (1.81)	496 (100)
Female	< 22 cm	34 (6.85)	26 (5.24)	8 (1.61)	1 (0.20)	0 (0.00)	0 (0.00)	69 (13.91)
	> 22 cm	271 (54.64)	6 (1.21)	0 (0.00)	0 (0.00)	121 (24.40)	29 (5.85)	427 (86.09)
	Total	305 (61.49)	32 (6.45)	8 (1.61)	1 (0.20)	121 (24.40)	29 (5.85)	496 (100)

Figures in the parentheses are percentage

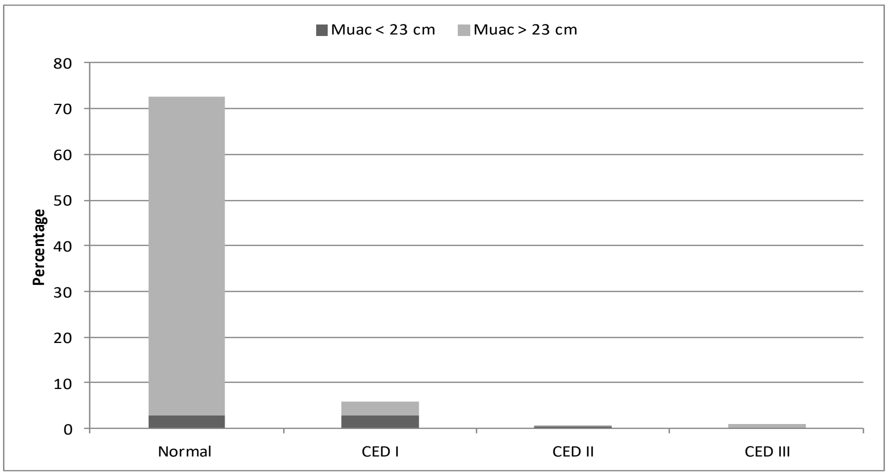


Figure 3.30a: Prevalence of undernutrition using combination of BMI and MUAC among the male Limboo individuals.

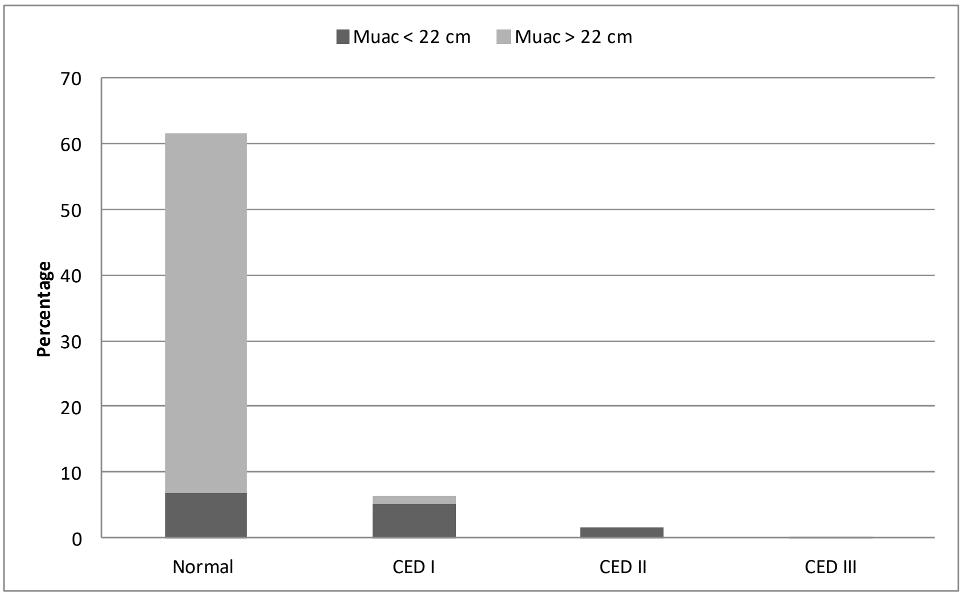


Figure 3.30b: Prevalence of undernutrition using combination of BMI and MUAC among the female Limboo individuals.

The combined prevalence of undernutrition given by MUAC with different grades of BMI is presented in Table 3.24. As observed there was 32 (6.45%) undernourished Limboo males identify by MUAC of which 15 (3.02%) was normal based on BMI category. Remaining 14 (2.82%), 2 (0.40%) and 1 (0.20%) male individuals was under the category of CED I, CED II and CED III, respectively. Similarly 69 (13.91%) Limboo female individuals was undernourished of which 34 (6.09%) was categorised as normal by BMI. The remaining 26 (5.24%), 8 (1.61%), 1 (0.20%) female individuals was categorised as CED I, CED II and CED III, respectively. These are represented in Figure 3.30a and 3.30b. Hence, the undernourished individual identified by MUAC as well as CED was 17 (3.42%) males and 35 (7.05%) females in the present study.

3.2.14 ASSESSMENT OF CENTRAL ADIPOSITY AND OVERALL ADIPOSITY AMONG LIMBOO INDIVIDUALS

The cut-offs for WC, WHtR (WHO 2000), WHR (WHO 2008) and CI (Valdez et al. 1993) along with BMI criteria for overweight (WHO 1995; 2000) has been utilised to identify the individuals at risk of adiposity related morbidity. This comparative prevalence is presented in Table 3.25. Based on BMI ($\geq$ 25kg/m^2) overweight/obesity was observed among 102 (20.56%) and 150 (30.24%), male and female Limboo individuals, respectively. The overall prevalence of overweight/obesity among the Limboos of the present study was 25.40%. The sex difference in the prevalence of overweight/obesity (BMI $\geq$ 25kg/m^2) between Limboo male and female was statistically significant (χ^2 – value 13.369; d.f.1; $p<0.001$). Individuals with BMI $\leq$ 25kg/m^2 were clubbed as “rest” in the table. The result of similar analysis using BMI of WHO (2000) showed 188 (37.90%) males and 235 (47.38%) females as overweight/obese (BMI $\geq$ 23kg/m^2). Irrespective of sex there were 423 (42.64%) individuals with BMI above 23 kg/m^2. The sex difference in the prevalence of high BMI (BMI $\geq$ 23kg/m^2) was observed to be significant (χ^2 – value 9.104; d.f.1; $p<0.05$) as presented in Table 3.25.

The WC is another index of adiposity has identified 54 (10.89%) males and 293 (59.07%) females Limboo individuals under the risk. Overall, 347 (34.98%) Limboo individuals were at risk of ill health associated with adiposity. The sex difference in the prevalence of ill health was statistically significant (χ^2 – value 253.174; d.f.1; $p< 0.05$). Similarly, utilizing WHtR 242 (48.79%) Limboo males and 408 (82.26%) Limboo females were identified at risk of adiposity related ill health. Overall 650 (65.52%) individuals were at risk of adiposity related diseases. The sex difference in the prevalence of risk was statistically significant (χ^2 – value 122.967; d.f.1; p< 0.05). The percentage prevalence is presented in Table 3.25 and Figure 3.31.

The other measure of central obesity such as WHR has identified 491 (98.99%) males and 473 (95.36%) females at the risk of adiposity related ill health. The overall prevalence of risk was 964 (97.18%) among the Limboo individuals of the present study. The sex difference in the incidence of risk was statistically significant (χ^2 – value 11.908; d.f.1; p< 0.05). The prevalence of risk due to adiposity identified by CI was 216 (43.55%) and 456 (91.94%) among the male and female Limboo individuals of West Sikkim. The overall prevalence of adiposity related risk was 672 (67.74%) among the studied population. The sex difference in the prevalence of adiposity related risk was statistically significant (χ^2 – value 265.714; d.f.1; p< 0.001).

Among the various indices used to assess adiposity the highest number of individuals at risk of adiposity related morbidity was identified by WHR (98.99%) followed by WHtR (48.79%), CI (43.55%), BMI/WHO 2000 (37.90), BMI/ WHO, 1995 (20.20%), and WC (10.89%) among the male Limboo individuals. Similarly, among female Limboo individuals, high adiposity was given by WHR (95.36%) followed by CI (91.94%), WHtR (82.26%), WC (59.07%), BMI/WHO 2000 (47.38), and BMI (30.20%). The overall adiposity risk assessed was highest for WHR (97.18%) followed by CI (67.74%), WHtR (65.52%), BMI/WHO 2000 (42.64), WC (34.98%), and BMI (25.20%). The trend observed for overall adiposity risk was similar to female Limboo individuals. Compare to male individuals females were more predisposed to adiposity related risk except for WHR. The findings are presented in Table 3.25 and Figure 3.31 in details.

Table 3.25: Prevalence of adiposity using different adiposity index among the Limboo individuals

Indices		Male (n=496)	Female (n=496)	Total (n=992)	χ2 -value
BMI (WHO 1995)	Rest	396 (79.80)	346 (69.80)	743 (74.80)	13.369**
	≥25kg/m^2	102 (20.56)	150 (30.24)	252 (25.40)	
BMI (WHO 2000)	Rest	308 (62.10)	261 (52.62)	569 (57.36)	9.104*
	≥23kg/m^2	188 (37.90)	235 (47.38)	423 (42.64)	
WC	Normal	442 (89.11)	203 (40.93)	645 (65.02)	253.174**
	At Risk	54 (10.89)	293 (59.07)	347 (34.98)	
WHtR	Normal	245 (49.40)	88 (17.74)	333 (33.57)	122.967**
	At Risk	242 (48.79)	408 (82.26)	650 (65.52)	
WHR	Normal	5 (1.01)	23 (4.64)	28 (2.82)	11.908**
	At Risk	491 (98.99)	473 (95.36)	964 (97.18)	
CI	Normal	280 (56.45)	40 (8.06)	320 (32.26)	265.714**
	At Risk	216 (43.55)	456 (91.94)	672 (67.74)	

*p<0.05; **p<0.01; d.f. = 1; Figures in the parentheses are percentage

3.2.14.1 Age specific prevalence of central adiposity among Limboo individuals.

The age and sex specific prevalence of high central obesity classified using WC (Table 3.26), WHtR (Table 3.27), WHR (Table 3.28), and CI (Table 3.29) among the Limboo individuals of Sikkim is detailed below. Utilizing WC the prevalence of central adiposity was observed high among the females (46.76 % vs. 71.71% vs. 60.00%) compared to males (5.82% vs. 12.96% vs. 16.48%) across the age groups in the present study. Further, 147 (71.71%) females of middle age group (30-49 years) and 15 (16.48%) males of 50-64 years were observed to be at high risk of central adiposity related morbidities utilizing WC as criterion. This is also depicted in Figure 3.32.

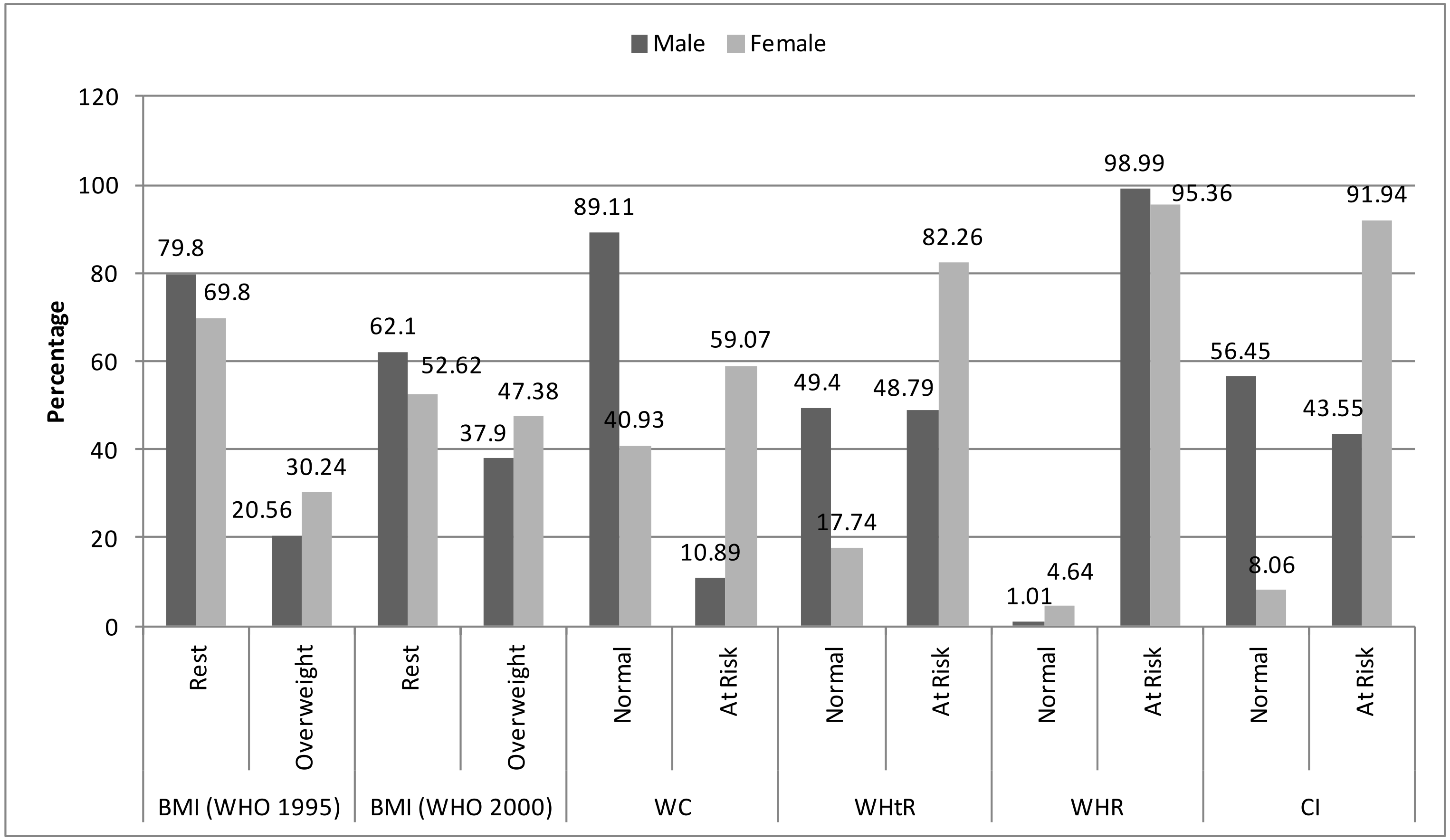


Figure 3.31: Comparison of adiposity given by general and central obesity indices of the Limboo individuals.

Table 3.26: Age and sex specific prevalence of central obesity using WC among the Limboo individuals

WC	18-29 years		30-49 years		50-64 years	
	Male	Female	Male	Female	Male	Female
High	11 (5.82)	101 (46.76)	28 (12.96)	147 (71.71)	15 (16.48)	45 (60.00)
Normal	178 (94.18)	115 (53.24)	188 (87.04)	58 (28.29)	76 (83.52)	30 (40.00)
Total	189 (100)	216 (100)	216 (100)	205 (100)	91 (100)	75 (100)

Figures in the parentheses are percentage

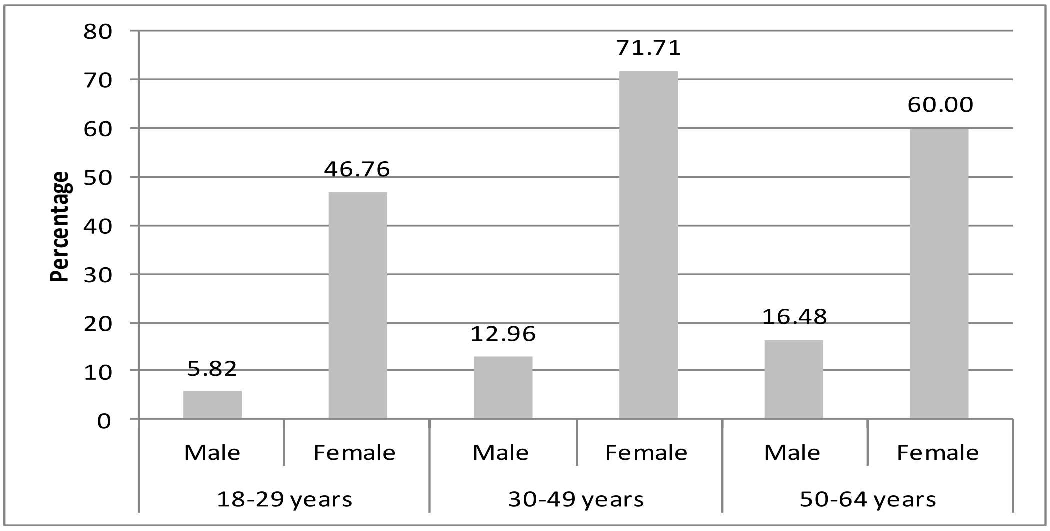


Figure 3.32: Age and sex specific distribution of WC related risk among the Limboo individuals.

A similar pattern of high central adiposity distribution was observed utilizing the WHtR as the female Limboo individuals being more centrally obese than the males (27.51% vs. 74.07%; 61.11 % vs. 90.24 %; 63.74% vs. 84.00%). The distribution is presented in Table 3.27. Further, among females of age group 30-49 years (90.24%) and among males the age group 50-64 years (63.74%) were at higher risk of central adiposity related morbidities using WHtR (Figure 3.33).

Table 3.27: Age and sex specific prevalence of central obesity using WHtR among the Limboo individuals

WHtR	18-29 years		30-49 years		50-64 years	
	Male	Female	Male	Female	Male	Female
High	52 (27.51)	160 (74.07)	132 (61.11)	185 (90.24)	58 (63.74)	63 (84.00)
Normal	137 (72.49)	56 (25.93)	84 (38.89)	20 (9.76)	33 (36.26)	12 (16.00)
Total	189 (100)	216 (100)	216 (100)	205 (100)	91 (100)	75 (100)

Figures in the parentheses are percentage

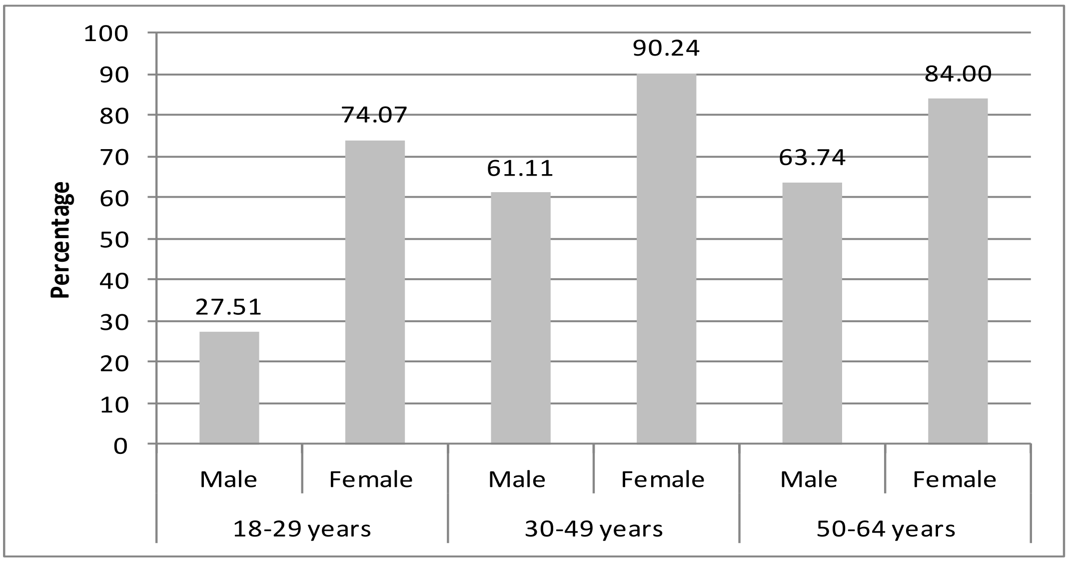


Figure 3.33: Age and sex specific distribution of WHtR related risk among the Limboo individuals.

The age and sex specific distribution of Limboo individuals based on WHR is presented in Table 3.28. The male individuals were observed at the high risk of central adiposity related risks compared to female individuals with narrow sex difference utilizing WHR as criteria across the age groups (98.94% vs. 94.44%, 99.07% vs. 97.07%, 98.90% vs. 93.33%). The high number of centrally obese individuals was observed among 30-49 years age group for both male and female Limboo individuals of the present study. The distribution is presented in Figure 3.34.

Table 3.28: Age and sex specific prevalence of central obesity using WHR among the Limboo individuals

WHR	18-29 years		30-49 years		50-64 years	
	Male	Female	Male	Female	Male	Female
High	187 (98.94)	204 (94.44)	214 (99.07)	199 (97.07)	90 (98.90)	70 (93.33)
Normal	2 (1.06)	12 (5.56)	2 (0.93)	6 (2.93)	1 (1.10)	5 (6.67)
Total	189 (100)	216 (100)	216 (100)	205 (100)	91 (100)	75 (100)

Figures in the parentheses are percentage

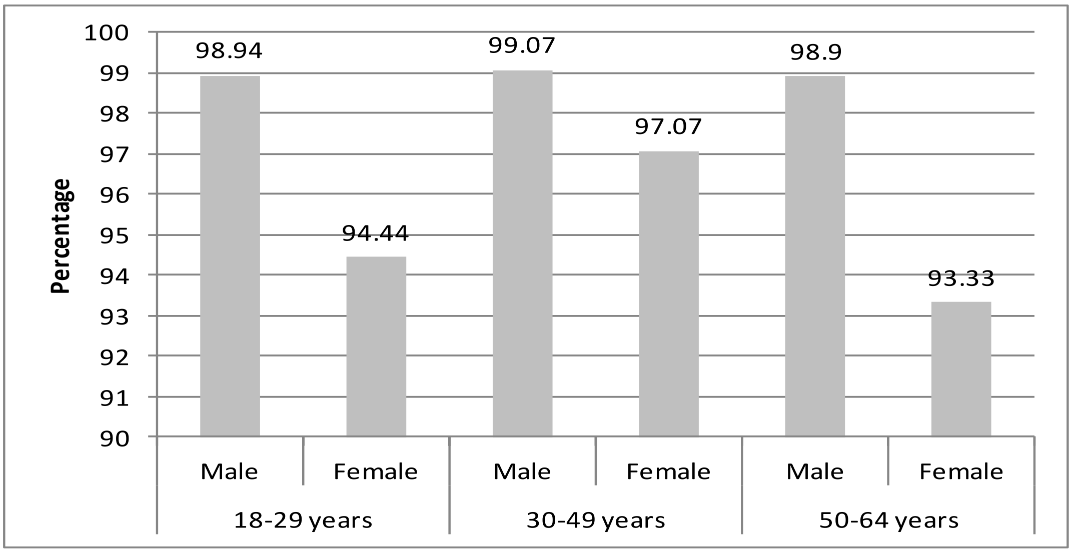


Figure 3.34: Age and sex specific distribution WHR related risk among the Limboo individuals.

Moreover, the prevalence pattern of central obesity utilizing CI was observed similar to that observed with WC and WHtR, where the prevalence was high among females across age groups (25.40% vs. 92.13%, 51.85% vs. 94.15%, 61.54% vs. 85.33%). Further, females of 30-49 years (94.15%) and males of 50-64 years (61.54%) were more at the risk of central adiposity related morbidities compared to Limboo individuals of other age groups. For details see Table 3.29 and Figure 3.35.

Table 3.29: Age and sex specific prevalence central obesity using CI among the Limboo individuals

CI	18-29 years		30-49 years		50-64 years	
	Male	Female	Male	Female	Male	Female
High	48 (25.40)	199 (92.13)	112 (51.85)	193 (94.15)	56 (61.54)	64 (85.33)
Normal	141 (74.60)	17 (7.87)	104 (48.15)	12 (5.85)	35 (38.46)	11 (14.67)
Total	189 (100)	216 (100)	216 (100)	205 (100)	91 (100)	75 (100)

Figures in the parentheses are percentage

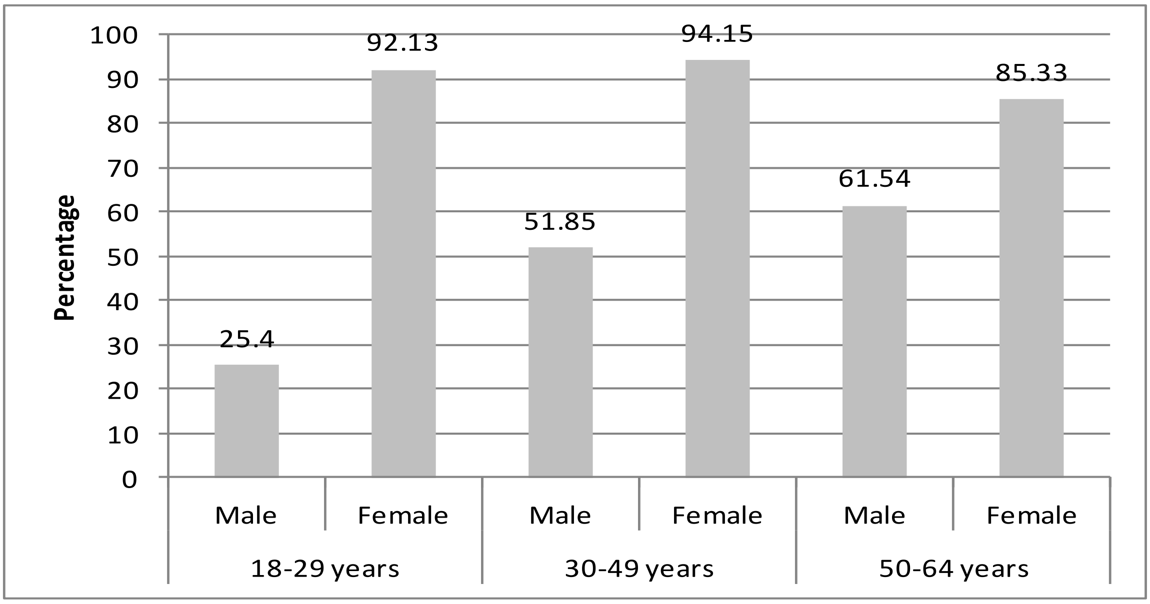


Figure 3.35: Age and sex specific distribution CI related risk among the Limboo individuals.

There was a significant difference between age groups in the prevalence of high central adiposity identified using WC (χ^2 – value 17.688; d.f.2; p<0.001) among the Limboo individuals of the present study. Similarly difference in the central adiposity prevalence identified using WHtR (χ^2 – value 52.924; d.f.2; p<0.001) and CI (χ^2 – value 14.290; d.f.2; p<0.001) among different age groups were observed significant except for central adiposity identified using WHR among the Limboo individuals of the present study.

3.2.15 EVALUTION OF ADIPOSITY USING BMI IN COMBINATION WITH WC, WHtR, WHR, AND CI

The high risk of illness due to excess adiposity was given by the cross combination of BMI with different indices of central adiposity such as WC, WHtR, WHR, and CI of male and female Limboo individuals is presented in Table 3.30 and 3.31 respectively. The individuals identified as normal by BMI and obese by WC was absent among Limboo males. Such normal weight centrally obese individuals as defined by BMI and WHR was highest 270 (54.44%) followed by 100 (20.16%) individuals defined by BMI and CI and finally 68 (13.71%) individuals defined by BMI and WHtR among the male Limboo individuals of the present study. Similarly, among female Limboo individuals normal weight centrally obese individuals as defined by BMI and WHR was highest 207 (41.73%) followed by 199 (40.12%) individuals defined by BMI and CI and then 165 (33.27%) individuals defined by BMI and WHtR and finally 76 (15.32%) individuals defined by BMI and WC.

Table 3.30: Prevalence of adiposity using BMI in combination with WC, WHtR, WHR, and CI among the male Limboo individuals

BMI	WC		WHtR		WHR		CI	
	Normal	High	Normal	High	Normal	High	Normal	High
< 18.5 kg/m^2	34 (6.85)	0 (0.00)	33 (6.65)	1 (0.20)	1 (0.20)	33 (6.65)	23 (4.64)	11 (2.22)
18.5-23 kg/m^2	274 (55.24)	0 (0.00)	206 (41.53)	68 (13.71)	4 (0.81)	270 (54.44)	174 (35.08)	100 (20.16)
> 23 kg/m^2	134 (27.02)	54 (10.89)	15 (3.02)	173 (34.88)	0 (0.00)	188 (37.90)	83 (16.73)	105 (21.17)
$\chi2$ - value	99.276**		232.254**		3.748		18.851**	

d.f. 2; * p<0.05; ** p< 0.001; Figures in the parentheses are percentage

Table 3.31: Prevalence of adiposity using BMI in combination with WC, WHtR, WHR, and CI among the female Limboo individuals

BMI	WC		WHtR		WHR		CI	
	Normal	High	Normal	High	Normal	High	Normal	High
< 18.5 kg/m2	37 (7.46)	4 (0.81)	30 (6.05)	11 (2.22)	7 (1.41)	34 (6.85)	8 (1.81)	33 (6.65)
18.5-23 kg/m2	144 (29.03)	76 (15.32)	55 (11.09)	165 (33.27)	13 (2.62)	207 (41.73)	21 (4.23)	199 (40.12)
> 23 kg/m2	22 (4.44)	213 (42.94)	3 (0.60)	232 (46.77)	3 (0.60)	232 (46.77)	11 (2.22)	224 (45.16)
χ2 - value	192.836**		137.909**		21.146**		11.527*	

d.f. 2; * p<0.05; ** p< 0.001; Figures in the parentheses are percentage

Further, participants were identified as simultaneously obese by BMI and each central obesity index such as WC, WHtR, WHR and CI separately. The combination of BMI and WC give the least number of simultaneously obese (10.89%) individuals among the male Limboo individuals of the present study. The male Limboo individuals were found affected higher in number by combined assessment of BMI with WHR 188 (37.90%), compared to combination with WHtR 173 (34.88%), and CI 105 (21.17%) among the males of the present study. Similarly, among female Limboo individuals cross combination of BMI with WHtR and with WHR identified the equal number of individual i.e. 232 (46.77%) at high risk of adiposity followed by CI 224 (45.16%) and WC 54 (10.89%).

The combined risk prevalence identified by BMI and a index of central adiposity was significant in case of WC (χ^2 – value 99.276; d.f.2; p< 0.001), WHtR (χ^2 – value 232.254; d.f.2; p< 0.001), CI (χ^2 – value 18.851; d.f.2; p< 0.001) and only in case WHR (χ^2 – value 3.748; d.f.2; p> 0.05) the prevalence was non-significant among male Limboo individuals. In contrast among female Limboo individuals of present study the prevalence of combined risk was significant in all cases such as WC (χ^2 – value 192.836; d.f.2; p< 0.001), WHtR (χ^2 – value 137.909; d.f.2; p< 0.001), WHR (χ^2 – value 21.146; d.f.2; p< 0.001), and CI (χ^2 – value 11.527; d.f.2; p< 0.05). The combined risk prevalence of adiposity among male and female Limboo individuals is presented in Figure 3.36 and 3.37, respectively.

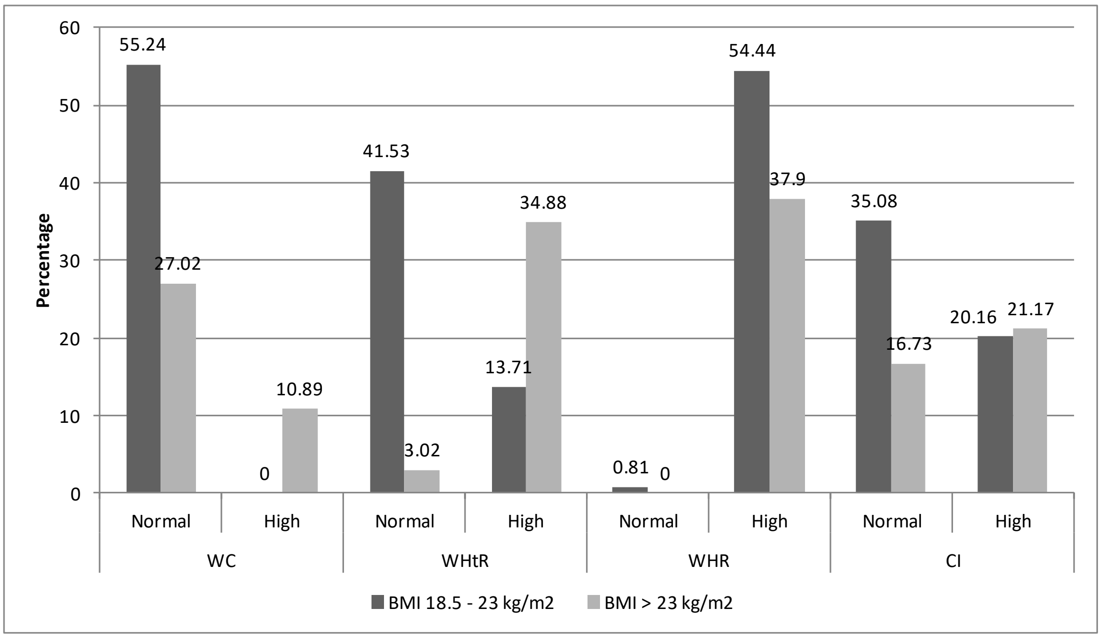


Figure 3.36: Prevalence of adiposity using BMI in combination with WC, WHtR, WHR, and CI among the male Limboo individuals.

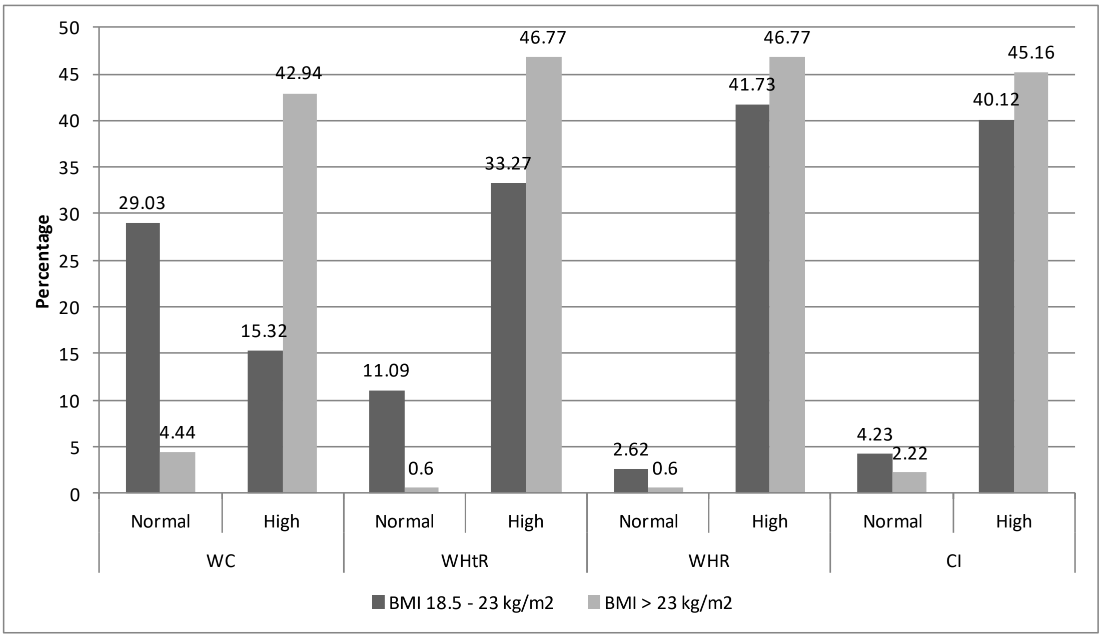


Figure 3.37: Prevalence of adiposity using BMI in combination with WC, WHtR, WHR, and CI among the female Limboo individuals.

3.3 BODY FAT AND FITNESS AMONG LIMBOO INDIVIDUALS.

3.3.1 PBF USING COMMONLY QUOTED 25/30 CRITERIA AMONG LIMBOO INDIVIDUALS.

Table 3.32 presents the distribution of PBF based on cut-offs of 25% for male and 30% for female cut-offs value. The overall prevalence of at risk Limboo individuals were 63 (6.35%) conversely a large number of individuals were below the level of risk related to adiposity. The sex wise prevalence of people at risk of adiposity related morbidity was 6 (1.21%) for male and 57 (11.49%) for female Limboo individuals of the present study. The $\chi 2$-test for the sex difference was found to be significant ($\chi 2$ = 44.085; d.f.1; $p<0.01$) in the prevalence of high PBF using 25% and 30% as cut-offs for male and female in the present study.

Table 3.32: Distribution of PBF based on 25% for male and 30% for female cut-offs among the Limboo individuals

Sex	N	Below	Above
Male	496	490 (98.79)	6 (1.21)
Female	496	439 (88.51)	57 (11.49)
Total	992	929 (93.65)	63 (6.35)

Figures in the parentheses are percentage

The age specific PBF classification is presented in Table 3.33. In the age group 18-29 years, 17 (7.87%) female Limboo individuals were at risk of higher adiposity compared to male 1 (0.53%) individuals. In the age group, 30-49 years, 4 (1.85%) male and 34 (16.59%) female Limboo individuals were at risk of higher adiposity. Similarly, in the age group, 50-64 years, 1 (1.10%) male and 6 (8.00%) female Limboo individuals were at the risk of higher adiposity. Across the age groups, the females were more at risk compared to males

The sex difference within age group such as 18-29 years ($\chi2$ = 12.792; d.f.1; p< 0.01), 30-49 years ($\chi2$ = 27.805; d.f.1; p< 0.01) and 50-64 years ($\chi2$ = 4.848; d.f.1; p< 0.05) in the observed PBF were significant. Further prevalence across the age groups were found to be significant ($\chi2$ = 8.812; d.f.1; p< 0.01). The distribution is also presented in Figure 3.38.

Table 3.33: Age and sex specific distribution of PBF using 25/30 cut-offs among the Limboo individuals

Age groups	Sex	N	Normal	High
18-29 years	Male	189	188 (99.47)	1 (0.53)
	Female	216	199 (92.13)	17 (7.87)
30-49 years	Male	216	212 (98.15)	4 (1.85)
	Female	205	171(83.41)	34 (16.59)
50-64 years	Male	91	90 (98.90)	1 (1.10)
	Female	75	69 (92.00)	6 (8.00)

Figures in the parentheses are percentage

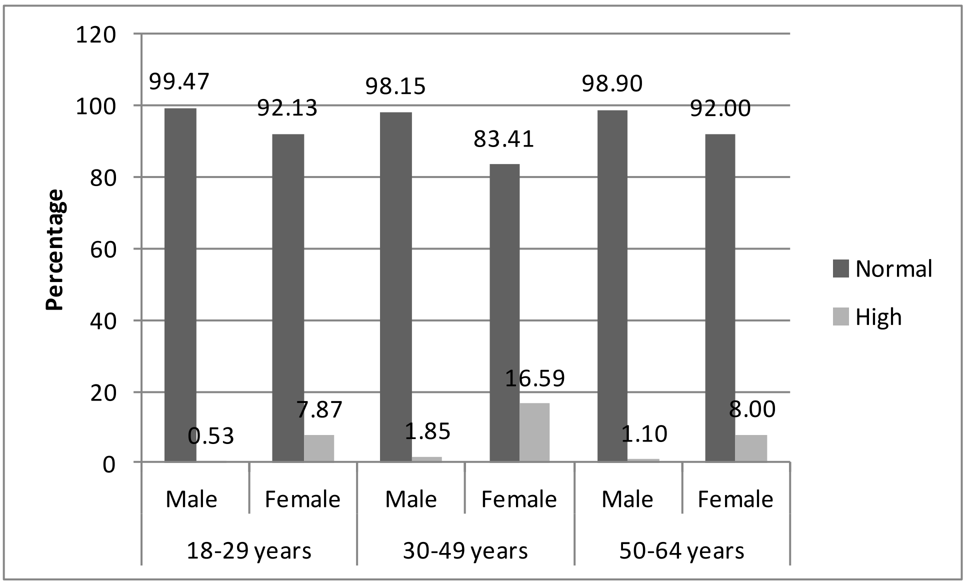


Figure 3.38: Age and sex specific distribution of PBF using 25/30 cut-offs among the Limboo individuals.

3.3.2 EVALUATION OF BODY FITNESS USING NIEMAN (1995) CLASSIFICATION.

The prevalence of adiposity related risk assessed using Nieman (1995) criteria for PBF among Limboo individuals is presented in Table 3.34. Overall 29.23% individuals were lean, followed by optimal fat (42.94%), fat (26.21%) and over fat (1.61%). Among male Limboo individuals prevalence of lean were 283 (57.06%) followed by optimal fat 203 (40.93%) and fat 10 (2.02%) individuals. Over fat, individuals were not found based on the criteria used in the present study. On the contrary, female Limboo individuals were more fat 250 (50.40%), followed by optimal fat 223 (44.96%), over fat 16 (3.23%) and lean 7 (1.41%). This is also presented in Figure 3.39. The sex difference in the occurrence of lean, fat and over fat individuals was significant except for optimal fat.

Table 3.34: Distribution of PBF using Nieman (1995) classification among the Limboo individuals

Sex	n	LEAN	OPTIMAL FAT	FAT	OVER FAT
Male	496	283 (57.06)	203 (40.93)	10 (2.02)	0 (0.00)
Female	496	7 (1.41)	223 (44.96)	250 (50.40)	16 (3.23)
Total	992	290 (29.23)	426 (42.94)	260 (26.21)	16 (1.61)

Figure in parentheses are percentage

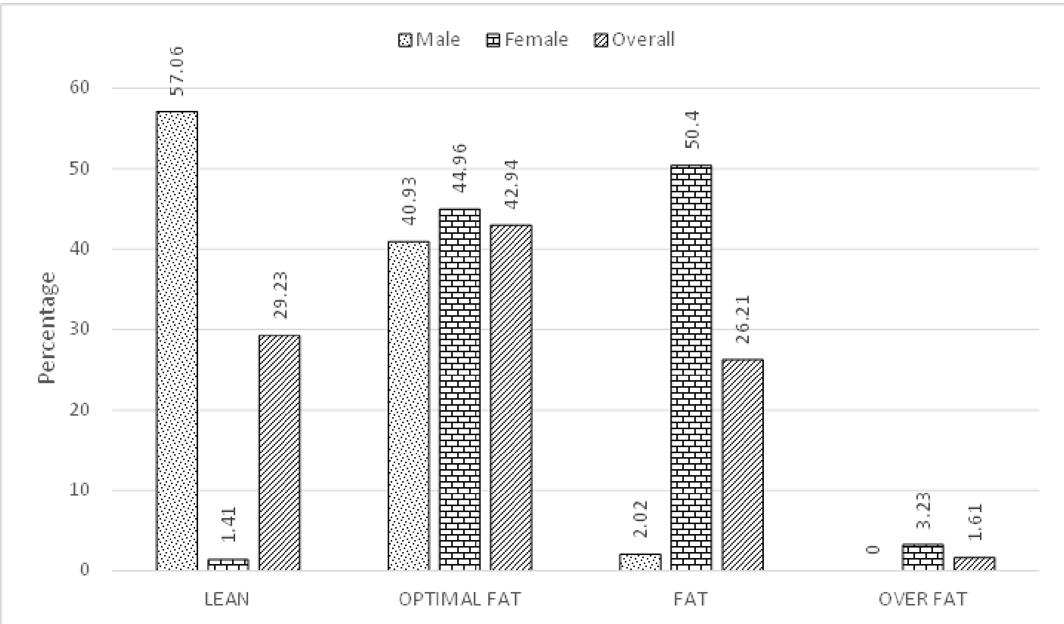


Figure 3.39: Distribution of body fitness using Nieman (1995) classification among the Limboo individuals.

Table 3.35: Age and sex specific distribution of PBF using Nieman (1995) classification among the Limboo individuals

Age group	Sex	n	Lean	Optimal fat	Fat	Over fat
18-29 years	Male	189	127 (67.20)	61 (32.28)	1 (0.53)	0 (0.00)
	Female	216	1 (0.46)	97 (44.91)	113 (52.31)	5 (2.31)
30-49 years	Male	216	98 (45.37)	111 (51.39)	7 (3.24)	0 (0.00)
	Female	205	3 (1.46)	78 (38.05)	116 (56.59)	8 (3.90)
50-64 years	Male	91	58 (63.74)	31 (34.07)	2 (2.20)	0 (0.00)
	Female	75	3 (4.00)	48 (64.00)	21 (28.00)	3 (4.00)

Figures in the parentheses are percentage

The age specific distribution of lean, optimal fat, fat, and over fat individuals according to Nieman (1995) is presented in Table 3.35. In the age group 18-29 years, lean male Limboo individuals were 127 (67.20%) and lean female Limboo individuals were 1 (0.46 %). The Limboo male individuals with optimal fat were 61 (32.280%) and Limboo female were 97 (44.91%). There were 1 (0.53%) fat male Limboo individuals and female Limboo individuals were 113 (52.31%). The over fat male Limboo individuals were 0 (0.00%) and female Limboo were 5 (2.31%). The sex difference in the occurrence of lean ($\chi 2$ = 207.66; d.f.1; $p < 0.01$), optimal fat ($\chi 2$ = 6.761; d.f.1; $p < 0.01$), fat ($\chi 2$ = 133.657; d.f.1; $p < 0.01$) and over fat ($\chi 2$ = 4.430; d.f.1; $p < 0.05$) were statistically significant within the age group.

In the age group 30-49 years, the lean male Limboo individuals were 98 (45.37%) and lean female Limboo individuals were 3 (1.46%). The male individuals with optimal fat were 111 (51.39%) and female individuals were 78 (38.05%). The fat male Limboo individuals were 7 (3.24%) and female individuals were 116 (56.59%). There were 0 (0.00%) over fat male individuals and 8 (3.90%) female individuals. The sex difference in the occurrence of lean ($\chi 2$ = 111.915; d.f.1; $p < 0.01$), optimal fat

($\chi2$ = 7.556; d.f.1; p< 0.01), fat ($\chi2$ = 144.727; d.f.1; p< 0.01) and over fat ($\chi2$ = 8.593; d.f.1; p< 0.01) were statistically significant within the age group.

Further in the age group 50-64 years, lean male Limboo individuals were 58 (63.74%) and female Limboo individuals were 3 (4.00%). The Limboo optimal fat males were 31 (34.07%) and the females were 48 (64.00%). There were 2 (2.20%) and 21 (28.00%) male and female fat Limboo individuals respectively. Over fat male Limboo individuals were 0 (0.00%) and over fat females were 3 (4.00%) in this age group. The sex difference in the occurrence of lean ($\chi2$ = 63.120; d.f.1; p< 0.01), optimal fat ($\chi2$ = 14.771; d.f.1; p< 0.01), fat ($\chi2$ = 22.933; d.f.1; p< 0.01) were statistically significant except for over fat ($\chi2$ = 3.707; d.f.1; p> 0.05) within the age group.

The higher numbers of lean Limboo male individuals were observed compared to lean female Limboo individuals across the three study age group according to PBF criteria by Nieman (1995). The $\chi2$ test for age group difference was significant ($\chi2$ = 11.225; d.f.2; p< 0.01) among the observed lean individuals. In the optimal fat category, the female Limboo individuals were higher in number except for 30-49 years age group and the observed age group difference was not significant. Similarly more females were fat and over fat compared to males of the present study. However, the trend was statistically significant for only fat ($\chi2$ = 15.855; d.f.2; p< 0.01) and not for over fat. The distribution is also presented in Figure 3.40.

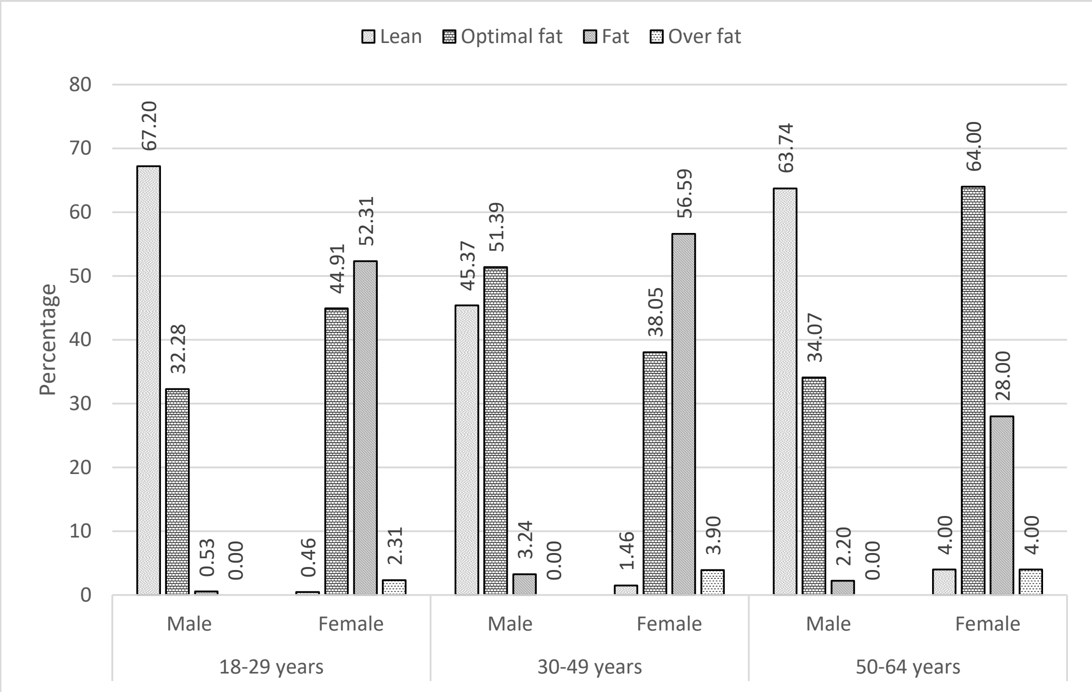


Figure 3.40: Age and sex specific distribution of PBF using Nieman (1995) classification among the Limboo individuals

3.3.3 EVALUATION OF BODY FITNESS USING MUTH (2009) CRITERIA.

Table 3.36 shows the distribution of PBF based on the criteria given by Muth (2009) among the Limboo male and female individuals. This system of classification has four categories as in the system given by Niemen (1995). In the present study more males were identified as underweight (6.45% vs. 1.61%) and more females were overweight (39.11% vs. 17.94%) and obese (4.84% vs. 1.21%) based on given PBF cut-offs (Muth, 2009). The difference between sexes among identified underweight individuals was statistically significant ($\chi 2$ = 15.34; d.f.1; $p < 0.01$). Similarly, difference between sex among the identified overweight ($\chi 2$ = 38.96; d.f.1; $p < 0.01$) and obese ($\chi 2$ = 10.80; d.f.1; $p < 0.01$) individuals were also statistically significant. The distribution according to Muth (2009) cut-offs is also presented in Figure 3.41.

Table 3.36: Distribution of PBF using Muth (2009) classification among the Limboo individuals

Sex	n	Normal	Underweight	Overweight/At risk	Obese/Morbid
Male	496	369 (74.40)	32 (6.45)	89 (17.94)	6 (1.21)
Female	496	270 (54.44)	8 (1.61)	194 (39.11)	24 (4.84)
Overall	992	639 (64.42)	40 (4.03)	283 (28.53)	30 (3.02)

Figures in the parentheses are percentage

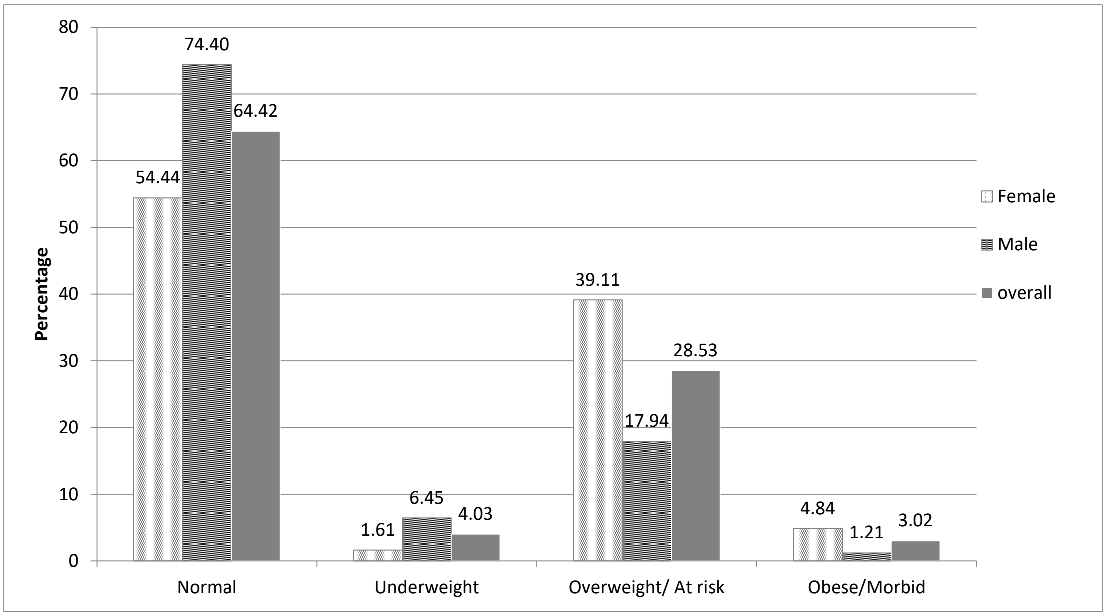


Figure 3.41: Distribution of PBF using Muth (2009) classification among Limboo individuals.

Table 3.37 presents the age group specific classification of Limboo male and female individuals according to the criteria of PBF by Muth (2009). In the age group, 18-29 years, more male Limboo individuals 10 (5.29%) were underweight compared to female Limboo individuals 1 (0.46%). On other hands, higher number of female Limboo individuals were identified as overweight (40.28%) and Obese (4.63%) compared to male Limboo individuals. The difference between sex among the identified underweight individuals were statistically significant ($\chi 2$ = 7.36; d.f.1; p< 0.01). The sex difference was also significant for overweight ($\chi 2$ = 37.24; d.f.1; p< 0.01) and obese ($\chi 2$ = 7.36; d.f.1; p< 0.01).

In the age group 30-49 years, the higher numbers of the Limboo male were lean compared to female Limboo individuals (6.48% vs. 1.46%). The overweight (45.37% vs. 25.46%) and obese (4.00% vs. 1.10%) female Limboo individuals were higher than the male Limboo individuals. The sex difference in the identification of underweight ($\chi 2$ = 7.12; d.f.1; p< 0.01) and overweight ($\chi 2$ = 9.76; d.f.1; p< 0.01) individuals were statistically significant. The sex difference in obese was not significant.

In the age group 50-64 years, underweight Limboo males were 8 (8.79%) and females were 4 (5.33%). As earlier the more females 14 (18.67%) were overweight than males 11 (12.09%) in the age group. The obese Limboo individuals were 3 (4.00%) females and 1 (1.10%) male. The sex difference in the identified underweight, overweight, and obese was not found significant in the age group 50-64 years. The prevalence of underweight given by Muth (2009) was observed higher among male individuals compared to females in both overall and age specific distributions. However, the overweight and obese individuals were observed higher among female Limboo individuals. The distribution is also presented in Figure 3.42.

Table 3.37: Age and sex specific distribution of PBF using Muth (2009) classification among the Limboo individuals

Age groups	Sex	n	Normal	Underweight	Overweight/ At risk	Obese/ Morbid
18-29 years	Male	189	155 (82.01)	10 (5.29)	23 (12.17)	1 (0.53)
	Female	216	118 (54.63)	1 (0.46)	87 (40.28)	10 (4.63)
30-49 years	Male	216	143 (66.20)	14 (6.48)	55 (25.46)	4 (1.85)
	Female	205	98 (47.80)	3 (1.46)	93 (45.37)	11 (5.37)
50-64 years	Male	91	71 (78.02)	8 (8.79)	11 (12.09)	1 (1.10)
	Female	75	54 (72.00)	4 (5.33)	14 (18.67)	3 (4.00)

Figures in the parentheses are percentage

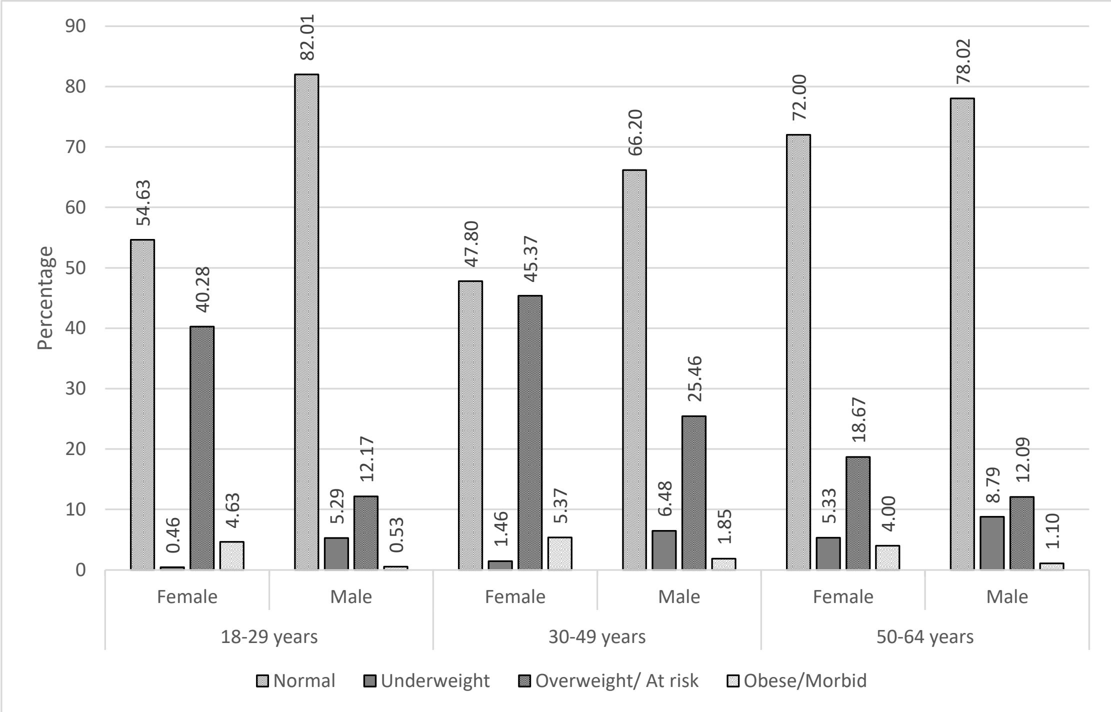


Figure 3.42: Age and sex specific distribution of PBF using Muth (2009) classification among the Limboo individuals.

3.3.4 EVALUATION OF COMPONENTS OF BODY COMPOSITION.

The distinguishing the components of body composition have the important implication on diseases and nutritional status assessment. The distribution of FMI and FFMI among the Limboo male and female individuals was conducted utilizing the cut-offs given by Khongsdier (2005) and Liu et al. (2013). According to Khongsdier (2005) cut-offs, 291 (58.67%) male individuals were identified with low FMI as the presented in Table 3.38. The high FFMI was observed among only 2 male individuals of the present study as presented in Table 3.38. The 2 individuals constituted 0.40% of male. Remaining individuals were identified as low FFMI and there were no individuals identified with normal FFMI.

Further, using sex specific cut-offs of FMI given by Liu et al. (2013), the Limboo female individuals (13.91%) were more at risk than Limboo male individuals (2.02%) in the present study (Table 3.39). The classification given using Liu et al.

(2013) is presented in Table 3.39. The sex difference using $\chi 2$ was found significant ($\chi 2 = 47.87$; d.f.1; p<0.001).

Table 3.38: Distributions of FMI and FFMI using Khongsdier (2005) classification among the male Limboo individuals

Index	n	Normal	Low	High
FMI	496	182 (36.69)	291 (58.67)	23 (4.64)
FFMI	496	0 (0.00)	494 (99.60)	2 (0.40)

Figures in the parentheses are percentage

Table 3.39: Distributions of FMI using Liu et al. (2013) classification among the Limboo individuals

Sex	n	Normal	At Risk
Male	496	486 (97.98)	10 (2.02)
Female	496	427 (86.09)	69 (13.91)
Overall	992	913 (92.04)	79 (7.96)

Figures in the parentheses are percentage

The age specific distribution of FMI observed using FMI cut-offs of Khongsdier (2005) is presented in Table 3.40. The FMI was observed high among the males of 30-49 years age group followed by 18-29 years age group and then 50-64 years age group. The prevalence of high FMI was 6.94% among 30-49 years age group male Limboo individuals. The high FMI was observed among 3.17% male Limboo individuals of 18-29 years and 2.20% male Limboo individuals of 50-64 years in the present study using cut-off given by Khongsdier (2005). In contrast, the prevalence of low FMI was observed more among males of 18-29 years (70.37%), followed by 50-64 years (64.84), and 30-49 years (45.83%) in the present study. As shown in Table 3.40 using cut-off given by Khongsdier (2005).

Similarly, age specific distribution of FMI using cut-offs given by Liu et al. (2013) is presented in Table 3.41. Using the cut-offs given by Liu et al. (2013) more male (3.24%) and female (20.98%) Limboo individuals of 30-49 years were observed at risk. The age 30-49 years were followed by 50-64 years (male: 2.20%; female: 10.67%) and then 18-29 years (male: 0.53%; female: 8.33%) according to high FMI or perceived risk (Table 3.41). However, the across age group females were more at risk than males. The obtained χ^2 results for age groups 18-29 years (χ^2 = 13.73; d.f.1; $p < 0.001$), 30-49 years (χ^2 = 31.61; d.f.1; $p < 0.001$), and 50-64 years (χ^2 = 5.21; d.f.1; $p < 0.05$) were statistically significant for the prevalence of high FMI using Liu et al. (2013) cut-offs.

Table 3.40: Age specific distribution of FMI using Khongsdier (2005) classification among male Limboo individuals

Age groups	Sex	N	Normal	Low	High
18-29 years	Male	189	50 (26.46)	133 (70.37)	6 (3.17)
30-49 years	Male	216	102(47.22)	99 (45.83)	15 (6.94)
50-64 years	Male	91	30 (32.97)	59 (64.84)	2 (2.20)

Figures in the parentheses are percentage

Table 3.41: Age and sex specific distributions of FMI using Liu et al. (2013) classification among the Limboo individuals

Age groups	Sex	N	Normal	At Risk
18-29 years	Male	189	188 (99.47)	1 (0.53)
	Female	216	198 (91.67)	18 (8.33)
30-49 years	Male	216	209 (96.76)	7 (3.24)
	Female	205	162 (79.02)	43 (20.98)
50-64 years	Male	91	89 (97.80)	2 (2.20)
	Female	75	67 (89.33)	8 (10.67)

Figures in the parentheses are percentage

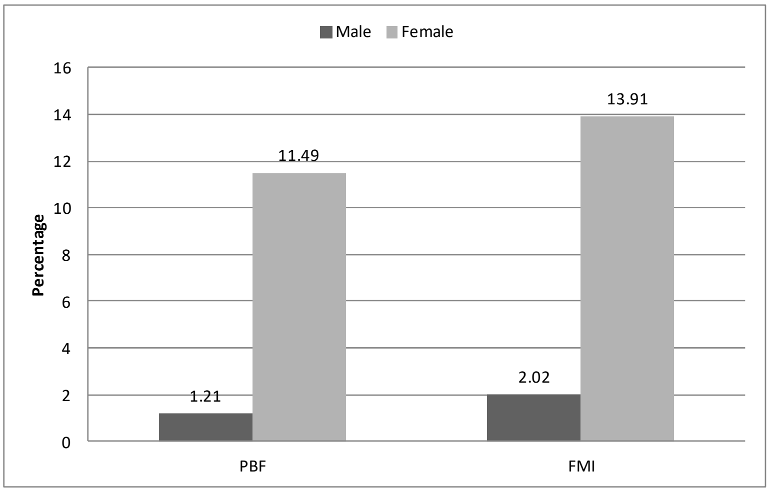


Figure 3.43: Comparison of the prevalence of the PBF and FMI related risk among the Limboo individuals

3.4 DETERMINANTS OF UNDERWEIGHT, OVERWEIGHT AND OBESITY AMONG LIMBOO INDIVIDUALS

The following analyses were an effort to show association of various demographic, socio-economic and life style determinants of underweight, overweight, and obesity among Limboo individuals of the present study. Further, analyses were made to identify possible factors among the different variables using logistic regression.

3.4.1 ASSOCIATION OF DEMOGRAPHIC, SOCIO-ECONOMIC, AND LIFE STYLE VARIABLES WITH OVERWEIGHT AND HIGH REGIONAL ADIPOSITY AMONG LIMBOO INDIVIDUALS.

The χ^2 test was conducted to understand the association of various demographic, socio-economic, and life style variables with the general adiposity defined using BMI above 25 kg/m^2 and regional adiposity defined using WC, WHtR, and WHR separately among male and female individuals of the present study. The results are discussed below in details.

3.4.1.1 Association of demographic, socio-economic, and life style variables with high BMI (≥ 25 kg/m^2) among male and female Limboo individuals.

Among the male Limboo individuals of the present study the prevalence of high BMI (≥ 25kg/m^2) was observe among the age group 30 – 49 years (12.30%), followed by 18 - 29 years (4.23%) and then 50 – 64 years (3.43%). Further, 86 (17.34%) married men and 55 (11.09%) men involved in the manual occupation were found to be associated with high BMI (≥ 25 kg/m^2). The educational attainments of male individuals were not found associated with high BMI (≥ 25 kg/m^2), however, monthly income, SES, and house type were found associated significantly. The monthly income of ≥ ₹10000/= consists of 13.10% male Limboo individuals followed by the monthly income of ₹5000/= - ₹9999/= (4.84%) and ₹4999/= (2.02%). The male individuals falling under the lower middle SES group of Kuppuswamy scale were 6.05% followed by upper middle (8.27%) and upper lower (5.65%). The dwelling like semi-pakka house showed 10.69% individuals with high BMI (≥ 25 kg/m^2) followed by kacha (3.43%) and pakka (3.43%) house type. The remaining variables like family size, land holding, house type, portable water, and toilet were not found associated with high BMI (≥ 25 kg/m^2). The χ^2 value is presented in Table 3.42a.

Association of high BMI (≥ 25 kg/m^2) with different demographic, socio-economic, and life style variables was same as that of male with one exception i.e. the educational attainments of female individuals were found associated significantly and monthly income was found associated non-significantly. The female Limboo individuals with high BMI (≥ 25 kg/m^2) were observed high among the individuals of age group 30 - 49 years (17.74%) followed by 18 – 29 years (7.46%) and 50 – 64 years (5.04%). The 132 (26.61%) married female individuals were more affected by high BMI ($\geq$ 25 kg/m^2) than 18 (3.63%) unmarried individuals. As in the case of male Limboo individuals the female Limboo individuals involved in manual occupations (23.79%) were found highly associated with increased BMI ($\geq$ 25 kg/m^2) followed by non-manual (5.24%) and others (1.21%). Trend noted in SES showed more individuals falling under the upper lower (14.11%) category followed by lower middle (8.25%) and upper middle (7.86%). The remaining variables like family size, land holding, house type, portable water, and hygienic toilet were not found associated with high BMI ($\geq$ 25 kg/m^2) among Limboo females of present study. The respective χ^2 value is presented in Table 3.42b.

3.4.1.2 Association of demographic, socio-economic, and life style variables with high BMI ($\geq$ 23 kg/m^2) among male and female Limboo individuals.

The variables like age, marital status, occupation, SES, family size, and house type were found significantly associated with high BMI ($\geq$ 23 kg/m^2) among the male Limboo individuals of the present study. The distribution of high BMI ($\geq$ 23 kg/m^2) was comparatively high among the individuals 30-49 years (21.98%) followed by 18-29 years (8.47%) and 50-64 years (7.46%). Again the married (31.85%) individuals were more exposed to adiposity inducing environment compared to unmarried (6.05%) male individuals. Among male individuals occupation involving manual labour seems more prone to high BMI 23 kg/m^2 as criteria. Male individuals falling under the upper lower (14.52%) category of kuppuswamy scale were more susceptible to high BMI ($\geq$ 23 kg/m^2) followed by lower middle (12.90%) and then upper middle (10.48%). People living in large family (27.42%) were more prone to high BMI ($\geq$ 23 kg/m^2). The male individuals dwelling Semi-Pakka house type were observed with high BMI (23 kg/m^2) followed by Pakka house type (8.87%) and Kacha house type (8.67%). The values are presented in Table 3.43a.

Among female Limboo individuals the variables like age marital status, occupation, and SES were found significant as in the case of male Limboo individuals. However, drinking water was observed associated significantly with high BMI ($\geq$ 23 kg/m^2) instead of variables like family size and house type. The distribution and trend noted for age group of individuals with high BMI ($\geq$ 23 kg/m^2) were similar to that of male Limboo individuals (30-49 years > 18-29 years > 50-64 years). The married individuals with high BMI were 199 (40.12%). The 184 (37.10%) female individuals involved in manual labour were observed with high BMI ($\geq$ 23 kg/m^2) followed by 33 (6.65%) non-manual and 18 (3.63%) other occupations. Individuals falling under the upper lower (23.19%) SES were more prone to high BMI ($\geq$ 23 kg/m^2) followed by lower middle (14.31%), and upper middle (9.88%). Lastly the individuals of house hold with drinking water piped from spring (28.43%) were more affected by high BMI then with government supply (18.97%) drinking water. For details refer Table 3.43b.

3.4.1.3 Association of demographic, socio-economic, and life style variables with high WC (female: > 80 cm; male: > 90 cm) related risk among male and female Limboo individuals.

The index of central adiposity, WC was observed significantly ($p<0.001$ and $p<0.05$) associated with age groups distribution, marital status, occupation, monthly income, SES, and house type (Table 3.44a). The male individuals with high WC were observed high in the age group 30 – 49 year (5.65%), followed by 50 – 64 years (3.02%) and 18 – 29 years (2.22%). The 51 (10.28%) married individuals, 29 (5.85%) individual with manual occupations, and 39 (7.86%) individuals of monthly income above ₹10000/= were observed to be associated with high central adiposity given by WC. Other variables like SES and house type were also found to be associated with

WC related adiposity. Such as semi-pakka house type (6.45%) and upper middle (4.44%) SES groups were observed with high percentage of individuals with WC related adiposity. The respective χ^2 value is given in Table 3.56a. The remaining variable like years of schooling, family size, land holding, drinking water facility, and toilet facility were not found associated with high WC (> 90 cm) among the male Limboo individuals of the present study.

Further, WC was observed significantly associated with age groups, marital status, occupation type, and SES among the female Limboo individuals of the present study. Unlike that of males 30 – 49 years age group (29.64%) were at higher risk followed by 18 – 29 years age group (20.36%) and 50 – 64 years age group (9.07%). Other variables like being married and involved in manual occupation were found to associate with high WC (≥ 80 cm) among female Limboos with 243 (48.99%) and 225 (45.36%) individuals respectively. A large percentage of females were found with high WC in the upper lower (30.44%) category of SES followed by lower middle (16.53%), and upper middle (12.10%). The association of remaining variables were not found significant and the χ^2 results are presented in Table 3.44b.

3.4.1.4 Association of demographic, socio-economic, and life style variables with high WHtR (> 0.05) related risk among male and female Limboo individuals.

The variables associated with high WHtR (> 0.05) among male Limboo individuals of the present study were age groups, marital status, occupation type, SES, house type, and toilet type. These variables were associated significantly with high WHtR (> 0.05). According to age groups distribution high numbers of individuals with high WHtR (> 0.05) were found among males of 30 – 49 years (26.61%) age group followed by 50 – 64 years (11.69%) and 18 – 29 years (10.48%). Once again

204 (41.13%) married male individuals were observed with high WHtR, 154 (31.05%) individuals involved in manual occupation were observed with high WHtR in the present study. The distributions of male Limboo individuals were observed high in the upper lower (20.77%) category of SES followed by lower middle (16.33%) and upper middle (31.05%). Similarly, male individual residing in semi-pakka (26.41%) house were at higher risk of high WHtR (≥ 0.05) followed by kacha (11.96%), and pakka (10.69%). The male Limboo individuals of house hold with commode toilets (44.35%) were found to be associated with high WHtR (≥ 0.05). The χ2 test results and other non-significantly associated variables for males are presented in Table 3.45a. In contrast to male Limboo individuals only age groups distribution and marital status were found associated with high WHtR (> 0.05) among females. The females of age group 30 – 49 years (37.30%) were observed with high incidence of high WHtR (> 0.05) followed by 18 – 29 years (32.26%) and 50 – 64 years (12.70%). The results of χ^2 test and distribution of other remaining variables are shown in Table 3.45b.

3.4.1.5 Association of demographic, socio-economic, and life style variables with high WHR (males: > 0.9; females: > 0.8) related risk among male and female Limboo individuals.

Among the male Limboo individuals of the present study high distribution of WHR related central adiposity was observed in age group 30 – 49 years (28.43%) followed by 18 – 29 years (14.92%) and 50 – 64 years (13.10%). Like in the previous indices the married (45.77%) individual were once again found associated with high adiposity related to WHR. The distribution of individuals with high WHR was observed with manual occupations (37.30%) followed by non-manual (15.12%) and others (4.03%) types of occupations. The remaining variables were not found associated significantly with high WHR among the male Limboo individuals of the presents study. The results of χ^2 test are presented in Table 3.46a. However among the female Limboo individuals of the present study none of the demographic, socio-economic, and life style variables were found associated significantly. The results are presented in Table 3.46b.

Table 3.42a: Association of demographic, socio-economic and life style variables with overweight among the male Limboo individuals

Variables	Categories	BMI < 25 kg/m^2	BMI > 25 kg/m^2	χ^2 – value
Age group	18-29 years	168 (33.87)	21 (4.23)	18.63; d.f.2; p<0.001
	30-49 years	155 (31.25)	61 (12.30)	
	50-64 years	74 (14.92)	17 (3.43)	
Marital status	Unmarried	122 (24.60)	13 (2.62)	12.39; d.f.1; p<0.001
	Married	275 (55.44)	86 (17.34)	
Education	Illiterate	59 (11.90)	11 (2.22)	3.43; d.f. 2; P>0.05
	Upto 8th grade	189 (38.10)	41 (8.27)	
	≥ 9th grade	149 (30.04)	47 (9.48)	
Occupation	Manual	276 (55.65)	55 (11.09)	40.10; d.f. 2 p<0.001
	Non-manual	62 (12.50)	42 (8.47)	
	Others	59 (96.72)	2 (0.40)	
Income	≤ ₹4999	48 (9.68)	10 (2.02)	9.23; d.f.2; p<0.01
	₹5000 – ₹9999	157 (31.65)	24 (4.84)	
	≥ ₹10000	192 (38.71)	65 (13.10)	
Kuppuswamy SES	Upper Middle (UM)	59 (11.90)	30 (6.05)	24.59; d.f.2; p<0.001
	Lower Middle (LM)	121 (24.40)	41 (8.27)	
	Upper Lower (UL)	217 (88.57)	28 (5.65)	
Family size	Small	137 (27.62)	30 (6.05)	0.62; d.f.1; p>0.05
	Large	260 (52.42)	69 (13.91)	
Land holding	0 – 0.99 acre	118 (23.79)	21 (4.23)	2.85; d.f. 1; p>0.05
	≥ 1 acre	279 (56.25)	78 (15.73)	
House type	Kacha	121 (24.40)	17 (3.43)	15.76;d.f. 2; p<0.001
	Semi-pakka	220 (44.35)	53 (10.69)	
	Pakka	56 (11.29)	17 (3.43)	
Drinking water	Supply	241 (48.59)	64 (12.90)	0.52; d.f.1; p>0.05
	Piped from spring	156 (31.45)	35 (7.06)	
Toilet	Pit	55 (11.09)	9 (1.81)	1.60;d.f.1; p>0.05
	Commode	342 (68.95)	90 (18.15)	

Figures in the parentheses are percentage

Table 3.42b: Association of demographic, socio-economic and life style variables with overweight among the female Limboo individuals

Variables	Categories	BMI < 25 kg/m^2	BMI > 25 kg/m^2	χ^2 – value
Age group	18-29 years	179 (36.09)	37 (7.46)	33.58; d.f.2; p<0.001
	30-49 years	117 (23.59)	88 (17.74)	
	50-64 years	50 (10.08)	25 (5.04)	
Marital status	Unmarried	94 (18.95)	18 (3.63)	13.77; d.f.1; p<0.001
	Married	252 (50.81)	132 (26.61)	
Education	Illiterate	114 (22.98)	61 (12.30)	6.03; d.f. 2; P<0.05
	Upto 8th grade	106 (21.37)	51 (10.28)	
	≥ 9th grade	126 (25.40)	38 (7.66)	
Occupation	Manual	263 (53.02)	118 (23.79)	21.42; d.f. 2 p<0.001
	Non-manual	27 (50.94)	26 (5.24)	
	Others	56 (11.29)	6 (1.21)	
Income	≤ ₹4999	43 (8.67)	13 (2.62)	14.12; d.f.2; p>0.001
	₹5000 – ₹9999	152 (30.65)	44 (8.87)	
	≥ ₹10000	151 (30.44)	93 (18.75)	
Kuppuswamy SES	Upper Middle (UM)	43 (8.67)	39 (7.86)	14.58; d.f.1; p<0.001
	Lower Middle (LM)	99 (19.96)	41 (8.25)	
	Upper Lower (UL)	204 (41.13)	70 (14.11)	
Family size	Small	112 (22.58)	54 (10.89)	0.62; d.f.1; p>0.05
	Large	234 (47.18)	96 (19.35)	
Land holding	0 – 0.99 acre	130 (26.21)	57 (11.49)	0.01; d.f. 1; p>0.05
	≥ 1 acre	216 (43.55)	93 (18.75)	
House type	Kacha	96 (19.35)	28 (5.65)	4.60; d.f. 2; p>0.05
	Semi-pakka	184 (37.30)	90 (18.15)	
	Pakka	66 (13.31)	32 (6.45)	
Drinking water	Supply	185 (67.52)	89 (17.94)	1.45; d.f.1; p>0.05
	Piped from spring	161 (32.46)	61 (12.30)	
Toilet	Pit	55 (11.09)	15 (3.02)	3.0; d.f.1; p>0.05
	Commode	291 (58.67)	135 (27.22)	

Figures in the parentheses are percentage

Table 3.43a: Association of demographic, socio-economic and life style variables with overweight based on BMI >23 kg/m^2 among the male Limboo individuals

Variables	Categories	BMI < 23 kg/m^2	BMI > 23 kg/m^2	χ^2 – value
Age group	18-29 years	147 (29.64)	42 (8.47)	34.52; d.f.2; p<0.001
	30-49 years	107 (21.57)	109 (21.98)	
	50-64 years	54 (10.89)	37 (7.46)	
Marital status	Unmarried	105 (21.17)	30 (6.05)	19.38; d.f.1; p<0.001
	Married	203 (40.93)	158 (31.85)	
Education	Illiterate	113 (22.78)	83 (16.73)	2.90; d.f.2; P>0.05
	Upto 8th grade	151 (30.44)	79 (15.93)	
	≥ 9th grade	44 (8.87)	26 (5.24)	
Occupation	Manual	216 (43.55)	115 (23.19)	36.11; d.f. 2 p<0.001
	Non-manual	41 (8.27)	63 (12.70)	
	Others	51 (10.28)	10 (2.02)	
Income	≤ ₹4999	40 (8.06)	18 (3.63)	7.32; d.f.2; p>0.05
	₹5000 – ₹9999	123 (24.80)	58 (11.69)	
	≥ ₹10000	145 (29.23)	112 (22.58)	
Kuppuswamy SES	Upper Middle (UM)	37 (7.46)	52 (10.48)	23.65; d.f.2; p<0.001
	Lower Middle (LM)	98 (19.76)	64 (12.90)	
	Upper Lower (UL)	173 (34.88)	72 (14.52)	
Family size	Small	115 (23.19)	52 (10.48)	4.90; d.f.1; p<0.05
	Large	193 (38.91)	136 (27.42)	
Land holding	0 – 0.99 acre	94 (18.95)	45 (9.07)	2.51; d.f. 1; p>0.05
	≥ 1 acre	214 (43.15)	143 (28.83)	
House type	Kacha	95 (19.15)	43 (8.67)	9.70; d.f. 2; p<0.05
	Semi-pakka	172 (34.68)	101 (20.36)	
	Pakka	41 (8.27)	44 (8.87)	
Drinking water	Supply	185 (37.30)	120 (24.19)	2.98; d.f.1; p>0.05
	Piped from spring	123 (24.80)	68 (13.71)	
Toilet	Pit	46 (9.27)	18 (3.63)	3.0; d.f.1; p>0.05
	Commode	262 (52.82)	170 (34.27)	

Figures in the parentheses are percentage

Table 3.43b: Association of demographic, socio-economic and life style variables with overweight based on 23kg/m^2 among the female Limboo individuals

Variables	Categories	BMI < 23 kg/m^2	BMI > 23 kg/m^2	χ^2 – value
Age group	18-29 years	141 (28.43)	75 (15.12)	28.02; d.f.2; p<0.001
	30-49 years	81 (16.33)	124 (25.00)	
	50-64 years	39 (7.86)	36 (7.26)	
Marital status	Unmarried	76 (15.32)	36 (7.26)	13.47; d.f.1; p<0.001
	Married	185 (37.30)	199 (40.12)	
Education	Illiterate	94 (18.95)	70(14.11)	2.17; d.f. 2; P>0.05
	Upto 8th grade	79 (15.93)	78 (15.73)	
	≥ 9th grade	88 (17.74)	87 (17.54)	
Occupation	Manual	197 (39.72)	184 (37.10)	13.21; d.f. 2 p<0.001
	Non-manual	20 (4.03)	33 (6.65)	
	Others	44 (8.87)	18 (3.63)	
Income	≤ ₹4999	34 (6.85)	22 (4.44)	6.03; d.f.2; p>0.05
	₹5000 – ₹9999	112 (22.58)	84 (16.94)	
	≥ ₹10000	115 (23.19)	129 (26.01)	
Kuppuswamy SES	Upper Middle (UM)	33 (6.85)	49 (9.88)	8.88; d.f.2; p<0.05
	Lower Middle (LM)	69 (13.91)	71 (14.31)	
	Upper Lower (UL)	159 (32.06)	115 (23. 19)	
Family size	Small	85 (17.14)	81 (16.33)	0.20; d.f.1; p>0.05
	Large	176 (35.48)	154 (31.05)	
Land holding	0 – 0.99 acre	97 (19.56)	90 (18.15)	0.07; d.f. 1; p>0.05
	≥ 1 acre	164 (33.06)	145 (29.23)	
House type	Kacha	72 (14.52)	52 (10.48)	3.24; d.f. 2; p>0.05
	Semi-pakka	144 (29.03)	130 (26.21)	
	Pakka	45 (9.07)	53 (10.69	
Drinking water	Supply	128 (25.81)	94 (18.97)	4.10; d.f.1; p<0.05
	Piped from spring	133 (26.81)	141(28.43)	
Toilet	Pit	38 (7.66)	32 (6.45)	0.91; d.f.1; p>0.05
	Commode	223 (44.96)	203 (40.93)	

Figures in the parentheses are percentage

Table 3.44a: Association of demographic, socio-economic and life style variables with WC related risk among the male Limboo individuals

Variables	Categories	WC< 90 cm	WC >90 cm	χ^2 – value
Age group	18-29 years	178 (35.89)	11 (2.22)	8.90; d.f.2; p<0.05
	30-49 years	188 (37.90)	28 (5.65)	
	50-64 years	76 (15.32)	15 (3.02)	
Marital status	Unmarried	132 (26.61)	3 (0.60)	14.35; d.f.1; p<0.001
	Married	310 (62.50)	51 (10.28)	
Education	Illiterate	62 (12.50)	8 (1.61)	0.80; d.f.2; P>0.05
	Upto 8th grade	208 (41.94)	22 (4.44)	
	≥ 9th grade	172 (34.68)	24 (4.84)	
Occupation	Manual	302 (60.89)	29 (5.85)	27.54; d.f.2 p<0.001
	Non-manual	79 (15.93)	25 (5.04)	
	Others	61 (12.30)	0 (0.00)	
Income	≤ ₹4999	56 (11.29)	2 (0.40)	10.74; d.f.2; p<0.01
	₹5000 – ₹9999	168 (33.87)	13 (2.62)	
	≥ ₹10000	218 (43.95)	39 (7.86)	
Kuppuswamy SES	Upper Middle (UM)	67 (13.51)	22 (4.44)	23.31; d.f.1; p<0.001
	Lower Middle (LM)	145 (29.23)	17 (3.43)	
	Upper Lower (UL)	230 (46.37)	15 (3.02)	
Family size	Small	151 (30.44)	16 (3.23)	0.44; d.f.1; p>0.05
	Large	291 (58.67)	38 (7.66)	
Land holding	0 – 0.99 acre	128 (25.81)	11 (2.22)	1.76; d.f.1; p>0.05
	≥ 1 acre	314 (63.31)	43 (8.67)	
House type	Kacha	132 (26.61)	6 (1.21)	11.80; d.f.2; p<0.01
	Semi-pakka	241 (48.59)	32 (6.45)	
	Pakka	69 (13.91)	16 (3.23)	
Drinking water	Supply	270 (54.44)	35 (7.06)	0.28; d.f.1; p>0.05
	Piped from spring	172 (34.68)	19 (3.83)	
Toilet	Pit	59 (11.90)	5 (1.01)	0.71; d.f.1; p>0.05
	Commode	383 (77.22)	49 (9.88)	

Figures in the parentheses are percentage

Table 3.44b: Association of demographic, socio-economic and life style variables with WC related risk among the female Limboo individuals

Variables	Categories	WC< 80 cm	WC >80 cm	χ^2 – value
Age group	18-29 years	115 (23.19)	101 (20.36)	χ^2 – value - 27.11; d.f.2; p<0.001
	30-49 years	58 (11.69)	147 (29.64)	
	50-64 years	30 (6.05)	45 (9.07)	
Marital status	Unmarried	62 (12.50)	50 (10.8)	χ^2 – value - 12.45; d.f.1; p<0.001
	Married	141 (28.43)	243 (48.99)	
Education	Illiterate	68 (13.71)	107 (21.57)	χ^2 – value - 3.80; d.f.2; P>0.05
	Upto 8th grade	58 (11.69)	99 (19.96)	
	≥ 9th grade	77 (15.52)	87 (17.54)	
Occupation	Manual	156 (31.45)	225 (45.36)	6.42; d.f.2 p<0.05
	Non-manual	15 (3.02)	38 (7.66)	
	Others	32 (6.45)	30 (6.05)	
Income	≤ ₹4999	28 (5.65)	28 (5.65)	3.54; d.f.2; p>0.05
	₹5000 – ₹9999	84 (16.94)	112 (22.58)	
	≥ ₹10000	91 (18.35)	153 (30.85)	
Kuppuswamy SES	Upper Middle (UM)	22 (4.44)	60 (12.10)	8.53; d.f.2; p<0.05
	Lower Middle (LM)	58 (11.69)	82 (16.53)	
	Upper Lower (UL)	123 (24.80)	151 (30.44)	
Family size	Small	76 (15.32)	90 (18.15)	2.43; d.f.1; p>0.05
	Large	127 (25.60)	203 (40.93)	
Land holding	0 – 0.99 acre	80 (16.13)	107 (21.57)	0.43; d.f. 1; p>0.05
	≥ 1 acre	123 (24.80)	186 (37.50)	
House type	Kacha	60 (12.10)	64 (12.90)	4.22; d.f. 2; p>0.05
	Semi-pakka	108 (21.77)	166 (33.47)	
	Pakka	35 (7.06)	63 (12.70)	
Drinking water	Supply	115 (23.19)	159 (32.06)	0.27; d.f.1; p>0.05
	Piped from spring	88 (17.74)	134 (27.02)	
Toilet	Pit	32 (6.45)	38 (7.66)	0.77; d.f.1; p>0.05
	Commode	171 (34.48)	293 (59.07)	

Figures in the parentheses are percentage

Table 3.45a: Association of demographic, socio-economic and life style variables with WHtR related risk among the male Limboo individuals

Variables	Categories	WHtR< 0.5	WHtR > 0.5	χ^2 – value
Age group	18-29 years	137 (27.62)	52 (10.48)	55.50; d.f.2; p<0.001
	30-49 years	84 (16.94)	132 (26.61)	
	50-64 years	33 (6.65)	58 (11.69)	
Marital status	Unmarried	97 (19.56)	38 (7.66)	31.63; d.f.1; p<0.001
	Married	157 (31.65)	204 (41.13)	
Education	Illiterate	31 (6.25)	39 (7.86)	1.66; d.f.2; P>0.05
	Upto 8^{th} grade	122 (24.60)	108 (21.77)	
	≥ 9^{th} grade	101 (20.36)	95 (19.15)	
Occupation	Manual	177 (35.69)	154 (31.05)	34.04; d.f.2 p<0.001
	Non-manual	31 (6.25)	73 (14.72)	
	Others	46 (9.27)	15 (3.02)	
Income	≤ ₹4999	28 (5.65)	30 (6.05)	5.30; d.f.2; p>0.05
	₹5000 – ₹9999	105 (21.17)	76 (15.32)	
	≥ ₹10000	121 (24.40)	136 (27.42)	
Kuppuswamy SES	Upper Middle (UM)	31 (6.25)	58 (11.69)	14.12; d.f.2; p<0.001
	Lower Middle (LM)	81 (16.33)	81 (16.33)	
	Upper Lower (UL)	142 (28.63)	103 (20.77)	
Family size	Small	89 (17.94)	78 (15.73)	0.44; d.f.1; p>0.05
	Large	165 (33.27)	164 (33.06)	
Land holding	0 – 0.99 acre	73 (14.72)	66 (13.31)	0.13; d.f. 1; p>0.05
	≥ 1 acre	181 (36,49)	176 (35.48)	
House type	Kacha	80 (16.13)	58 (11.69)	8.85; d.f. 2; p<0.05
	Semi-pakka	142 (28.63)	131 (26.41)	
	Pakka	32 (6.45)	53 (10.69)	
Drinking water	Supply	154 (31.05)	151 (30.44)	0.16; d.f.1; p>0.05
	Piped from spring	100 (20.16)	91 (18.35)	
Toilet	Pit	42 (8.47)	22 (4.44)	6.11; d.f.1; p<0.05
	Commode	212 (42.74)	220 (44.35)	

Figures in the parentheses are percentage

Table 3.45b: Association of demographic, socio-economic and life style variables with WHtR related risk among the female Limboo individuals

Variables	Categories	WHtR< 0.5	WHtR > 0.5	χ^2 – value
Age group	18-29 years	56 (11.29)	160 (32.26)	19.02; d.f.2; p<0.001
	30-49 years	20 (4.03)	185 (37.30)	
	50-64 years	12 (2.42)	63 (12.70)	
Marital status	Unmarried	27 (5.44)	85 (17,14)	4.02; d.f.1; p<0.05
	Married	61 (12.30)	323 (65.12)	
Education	Illiterate	29 (5.85)	146 (29.44)	2.26; d.f. 2; P>0.05
	Upto 8th grade	24 (4.84)	133 (26.81)	
	≥ 9th grade	35 (7.06)	129 (26.01)	
Occupation	Manual	66 (13.31)	315 (63.51)	1.30; d.f. 2 p>0.05
	Non-manual	8 (1.61)	45 (9.07)	
	Others	14 (2.82)	48 (9.68)	
Income	≤ ₹4999	8 (1.61)	48 (9.68)	0.87; d.f.2; p>0.05
	₹5000 – ₹9999	38 (7.66)	158 (31.85)	
	≥ ₹10000	42 (8.47)	202 (40.73)	
Kuppuswamy SES	Upper Middle (UM)	12 (2.42)	70 (14.11)	1.45; d.f.2; p>0.05
	Lower Middle (LM)	29 (5.85)	111 (22.38)	
	Upper Lower (UL)	47 (9.48)	227 (45.77)	
Family size	Small	27 (5.44)	139 (28.02)	0.34; d.f.1; p>0.05
	Large	61 (12.30)	269 (52.23)	
Land holding	0 – 0.99 acre	35 (7.06)	152 (3.65)	0.20; d.f. 1; p>0.05
	≥ 1 acre	53 (10.69)	256 (51.61)	
House type	Kacha	24 (4.84)	100 (20.16)	0.62; d.f. 2; p>0.05
	Semi-pakka	49 (9.88)	225 (45.36)	
	Pakka	15 (3.02)	83 (16.73)	
Drinking water	Supply	50 (10.08)	224 (45.16)	0.10; d.f.1; p>0.05
	Piped from spring	38 (7.66)	184 (37.10)	
Toilet	Pit	15 (3.02)	55 (11.09)	0.76; d.f.1; p>0.05
	Commode	73 (14.72)	353 (71.17)	

Figures in the parentheses are percentage

Table 3.46a: Association of demographic, socio-economic and life style variables with WHR related risk among the male Limboo individuals

Variables	Categories	WHR< 0.9	WHR > 0.9	χ^2 – value
Age group	18-29 years	115 (23.19)	74 (14.92)	38.15; d.f.2; p<0.001
	30-49 years	75 (15.12)	141 (28.43)	
	50-64 years	26 (5.26)	65 (13.10)	
Marital status	Unmarried	82 (16.53)	53 (10.69)	22.30; d.f.1; p<0.001
	Married	134 (27.02)	227 (45.77)	
Education	Illiterate	29 (5.85)	41 (8.27)	0.48; d.f. 2; P>0.05
	Upto 8^{th} grade	98 (19.76)	132 (26.61)	
	≥ 9^{th} grade	89 (17.94)	107 (21.57)	
Occupation	Manual	146 (29.44)	185 (37.30)	24.31; d.f. 2 p<0.001
	Non-manual	29 (5.85)	75 (15.12)	
	Others	41 (8.27)	20 (4.03)	
Income	≤ ₹4999	21 (4.23)	37 (7.46)	1.89; d.f.2; p>0.05
	₹5000 – ₹9999	84 (16.94)	97 (19.56)	
	≥ ₹10000	111 (22.38)	146 (29.44)	
Kuppuswamy SES	Upper Middle (UM)	30 (6.05)	59 (11.90)	4.95; d.f.2; p>0.05
	Lower Middle (LM)	70 (14.11)	92 (18.55)	
	Upper Lower (UL)	116 (23.39)	129 (26.01)	
Family size	Small	68 (13.71)	99 (19.96)	0.82; d.f.1; p>0.05
	Large	148 (29.84)	181 (36.47)	
Land holding	0 – 0.99 acre	57 (11.49)	82 (16.53)	0.20; d.f.1; p>0.05
	≥ 1 acre	159 (32.06)	198 (39.92)	
House type	Kacha	58 (11.69)	80 (16.13)	0.57; d.f. 2; p>0.05
	Semi-pakka	123 (24.80)	150 (30.24)	
	Pakka	35 (47.06)	50 (10.08)	
Drinking water	Supply	141 (28.43)	164 (33.06)	0.10; d.f.1; p>0.05
	Piped from spring	75 (15.12)	116 (23.39)	
Toilet	Pit	29 (5.85)	35 (7.06)	0.76; d.f.1; p>0.05
	Commode	187 (37.70)	245 (49.40)	

Figures in the parentheses are percentage

Table 3.46b: Association of demographic, socio-economic and life style variables with WHR related risk among the female Limboo individuals

Variables	Categories	WHR< 0.8	WHR > 0.8	χ^2 – value
Age group	18-29 years	12 (2.42)	204 (41.13)	2.46; d.f.2; p>0.05
	30-49 years	6 (1.21)	199 (40.12)	
	50-64 years	5 (1.01)	70 (14.11)	
Marital status	Unmarried	8 (1.61)	104 (20.97)	2.05; d.f.1; p>0.05
	Married	15 (3.02)	369 (74.40)	
Education	Illiterate	10 (2.02)	165 (33.27)	0.48; d.f. 2; P>0.05
	Upto 8th grade	4 (0.81)	153 (30.85)	
	≥ 9th grade	9 (1.81)	155 (31.25)	
Occupation	Manual	16 (3.23)	365 (73.59)	1.18; d.f. 2 p>0.05
	Non-manual	4 (0.81)	49 (9.88)	
	Others	3 (0.60)	59 (11.90)	
Income	≤ ₹4999	2 (0.40)	54 (10.89)	0.24; d.f.2; p>0.05
	₹5000 – ₹9999	10 (2.02)	186 (38.50)	
	≥ ₹10000	11 (2.22)	233 (46.98)	
Kuppuswamy SES	Upper Middle (UM)	5 (1.01)	77 (15.52)	0.47; d.f.2; p>0.05
	Lower Middle (LM)	6 (1.21)	134(27.02)	
	Upper Lower (UL)	12 (2.42)	262 (52.82)	
Family size	Small	7 (1.41)	159 (32.06)	0.10; d.f.1; p>0.05
	Large	16 (3.23)	314 (63.31)	
Land holding	0 – 0.99 acre	7 (1.41)	180 (36.29)	0.54; d.f. 1; p>0.05
	≥ 1 acre	16 (3.23)	293 (59.07)	
House type	Kacha	9 (1.81)	115 (23.19)	3.11; d.f. 2; p>0.05
	Semi-pakka	9 (1.81)	265 (43.43)	
	Pakka	9 (1.81)	115 (23.19)	
Drinking water	Supply	16 (3.23)	258 (52.02)	2.00; d.f.1; p>0.05
	Piped from spring	7 (1.41)	215 (43.35)	
Toilet	Pit	3 (0.60)	67 (13.51.)	0.02; d.f.1; p>0.05
	Commode	20 (4.03)	406 (81.85)	

Figures in the parentheses are percentage

3.4.2 RESULT OF LOGISTIC REGRESSION TO ACERTAIN POSSIBLE DETERMINANTS OF UNDERWEIGT, OVERWEIGHT, OBESITY AND CENTRAL ADIPOSITY.

The multinomial logistic regressions were conducted to identify the possible determinants of undernutrition and overweight among the Limboo population of Sikkim in the present study. Multinomial logistic regressions were carried out to find out possible factors for underweight, overweight, and obesity given by BMI (WHO 1995). Similarly, multinomial logistic regressions were carried out to identify possible factors causing high central adiposity among the Limboo population based on WC, WHtR, and WHR. The respective results are delineated below.

3.4.2.1 Multinomial logistic regression for being underweight, overweight and obese using BMI WHO (1995) classification.

The multinomial logistic regression was performed to analyse the effect of various socio-economic and socio-demographic variables on the outcome variables like underweight, overweight and obese compare to normal weight individuals using BMI (1995) classification. The socio-economic and socio-demographic variables were sex (male; female), age (18-29 years; 30-49 years;50-64 years), marital status (unmarried; married), education (illiterate; upto 8^{th} grade; $\geq 9^{th}$ grade), occupation (manual; non-manual; others), monthly income (≤ ₹4999/=; ₹5000/= - ₹9999/=; ≥ ₹10000/=), socio-economic status based on Kuppuswamy scale (upper lower; lower middle; upper middle), family size (large; small), land holding (≥1 acre; 0-0.99 acre), house type (semi-pakka; pakka; kacha), drinking water (supply; piped from spring) and hygienic toilet (Commode; pit). The words in the brackets are categories of the each variable which were used as predictors.

Multinomial logistic regression analyses result for being underweight compare to normal weight individuals was only significant ($p<0.05$) for middle age group (30 - 49 years) with odd of 0.48 (95% CI 0.27 – 0.85) than the young adults. However, the odd ratio was less than 1 which suggests the event is significantly less likely to occur. The observed non-significant odds of 50 – 64 years age group was 0.73 (95% CI 0.37-1.42) indicate their less likelihood of being underweight compared to 18-29 years age group. All the other variables have non-significant ($p>0.05$) odds for being underweight. The education categories upto 8th grade and above 9th grade, land holding below 1 acre, kacha house dwelling, Pakka house dwelling, presence of unhygienic toilet facility have less likelihood of being underweight with non-significant ($p>0.05$) odds. Other variable like being female, married, occupation involving manual and non-manual work, income of ₹5000/= – ₹9999/=, income of ≥ ₹10000/=, upper middle (UM) SES, lower middle (LM) SES based on Kuppuswamy scale, small family size and drinking water piped from spring have non-significant ($p>0.05$) odd of above 1. The values are presented in Table 3.47.

The odd ratios obtained for being overweight compare to normal weight were significant ($p<0.05$) for sex, age groups, marital status, occupation, income, and socio-economic status based on Kuppuswamy scale. The odd of being overweight for females was 1.57 (95% CI 1.15 – 2.14) times than males. Age group 30 – 49 years have highly significant ($p < 0.001$) odd of 3.01 (95% CI 2.09 – 4.33) for being overweight and older age group 50-64 years have significant ($p < 0.05$) odd of 1.76 (95% CI 1.08 – 2.87) compare to age group 18-29 years. Married individuals have highly significant ($p<0.001$) odd of 3.27 (95% CI 2.07 – 5.17) for being effected by overweight. Similarly highly significant ($p < 0.001$) odds were observed for manual occupation (OR: 4.64, 95% CI 2.11 – 10.19) and non-manual occupation (OR: 11.12, 95% CI 4.82 – 25.67). The odd of income above ₹10000/= (OR: 1.77, 95% CI 1.05 – 2.97) was observed significant ($p<0.01$) against the income ≤ ₹4999/= and income of ₹5000/= – ₹9999/=. The upper middle (UM) and lower middle (LM) levels of SES against upper lower (UL) were observed with highly significant ($p<0.001$) odd of 2.92 (95% CI 1.94 – 4.38) and significant odd of 1.62 (95% CI 1.13 – 2.33) respectively. The remaining variables such as levels of education, family size, landholding source of drinking water and hygienic toilet have non-significant odds values less than 1 for being overweight. Only kacha house type was observed with odd above 1 which was observed non- significant ($p>0.05$).

The result of multinomial logistic regression analyses for being obese compare to normal BMI individuals were highly significant ($p<0.001$) for female, 30-49 years age group and LM level of SES. Similarly significant ($p<0.05$) odd were observed 50 – 64 years age, non-manual occupation and piped source of drinking water. The chance of being obese for female was 3.11 (95% CI 1.53 – 6.33) times than male. The middle age group (OR: 3.94, 95% CI 1.66 – 9.33) and old age group (OR: 3.89, 95% CI 1.44 – 10.46) individuals have higher likelihood of being obese compared to young adults. Individuals with non-manual occupation were more likely to get obese than manual occupation and the "other" occupation category with odd ratio of 14.76 (95% CI 1.87 – 116.70). The individual of high SES such as UM was 3.38 (95% CI 1.53 – 7.47) times likely to get obese compared to individual of UL SES level. The individuals with education upto 8^{th} grade and piped source of drinking water were significantly ($p<0.05$) less likely to get obese with odd ratios of 0.42 (95% CI 0.19 – 0.94) and 0.45 (95% CI 0.22 – 0.93) respectively. The remaining variables were non-significant such as marital status, higher education, income levels, LM level of SES, family size, land holding, house types, and hygienic toilet (Table 3.47).

3.4.2.3 Multinomial logistic regression for being at high WC (male: > 90 cm; female: > 80 cm).

The multinomial logistic regression was performed to analyse the effect of various demographic, socio-economic and life style variables for predisposing the individuals to various adiposity related morbidity based on waist circumference (WC) measurement (Table 3.48). The outcome variables are being at risk of higher WC and not at risk which is mark off by WHO cut off for waist circumference (90 cm for male and 80 cm for female). Lower WC or not at risk was set as reference. The demographic, socio-economic and life style variables used were same as that used in case of multinomial logistic regression of using BMI.

The logistic regression analyses for being at risk of high WC compared to normal WC measurement were highly significant ($p<0.05$) for sex, middle age groups, marital status, education, and UM SES. The significant odds were observed for 50 – 64 years, occupations, family monthly income ≥ ₹10000, and Kacha house type. The females were more at risk of high regional adiposity measured by WC compared to males (OR: 11.81, 95% CI 8.46 – 16.51). The age group 30 – 49 years and 50 – 69 years were 1.86 (95% CI 1.39 – 2.49) and 1.48 (95% CI 1.01 – 2.18) times likely to be at risk of high WC compared to young individuals of age group 18 – 29 years respectively. The married individuals were 2.39 (95% CI 1.70 – 3.34) times likely to be centrally obese against the unmarried individuals of the present study. Compared to the others occupation category non-manual occupation have significant odds of 2.08 (95% CI 1.23 – 3.50) even higher than 1.72 (95% CI 1.11 – 2.67) observed for manual occupation. The high income group with family monthly income of ≥ ₹10000/= were observed with odds of 1.74 (95% CI 1.11 – 2.74). Individuals falling under the UM SES level were more prone to high WC with highly significant odd of 1.96 (95% CI 1.38 – 2.79).

On the other hand individuals dwelling kacha house were observed with less likelihood of being at risk of high WC with significant ($p<0.05$) odds of 0.64 (95% CI 0.47 – 0.89). The odd ratios observed for remaining variables were non-significant ($p > 0.05$) which are presented in Table 3.48.

3.4.2.5 Multinomial logistic regression for being at risk of high WHtR(> 0.5).

The multinomial logistic regression was performed to analyse the effect of various demographic, socio-economic and life style variables for predisposing the individuals to various adiposity related morbidity based on WHtR (Table 3.49). The outcome variables were being at risk of higher WHtR and not at risk which is mark off by WHO (2008) cut off for WHtR (> 0.5 for both sexes). The demographic, socio-economic and life style variables are same as used in previous logistic regressions.

The results for being at risk of high WHtR compared to normal WHtR were highly significant ($p<0.05$) for sex, age group, marital status, education and occupations. The Limboo female individuals were at high risk with significant odds of 4.87 (95% CI 3.64 – 6.50) compared to male individuals. Further, compared to younger age group older age group 30-49 years and 50-64 years were more predisposed to risk of high WHtR with odds of 2.78 (95% CI 2.07 – 3.73) and 2.45 (95% CI 1.65 – 3.63) respectively. Comparatively middle age group individuals were more at risk. The married individuals were 2.44 (95% CI 1.81 – 3.27) times likely to be at the high WHtR against unmarried individuals. The individuals involved in non-manual occupation (OR: 2.88, 95% CI 1.74 – 4.78) and manual occupation (OR: 1.84, 95% CI 1.25 – 2.70) were more likely to be centrally obese against 'other' occupation, the odds observed were higher for non-manual occupation. Lastly individuals falling under the UM SES and Pakka house were significantly at risk of high central adiposity using WHtR the odds observed were 1.71 (95% CI 1.16 – 2.52) and 1.55 (95% CI 1.07 – 2.26) respectively.

The odds of people educated upto 8^{th} grade and $\geq 9^{th}$ grade were observed with 0.54 (95% CI 0.38 – 0.77) and 0.53 (95% CI 0.37 – 0.77) respectively. This suggests educated people are significantly less likely to get centrally obese using the WHtR as marker. The unhygienic toilets were found significantly less likely to influence the prevalence of high central obesity. The odds observed for absent of hygienic toilet were 0.67 (0.46 – 0.97). The remaining variables have no influence in the prevalence of central obesity. The figures are presented in Table 3.49.

3.4.2.6 Multinomial logistic regression for being at high WHR (male: > 0.90; female: > 0.80).

The multinomial logistic regression was performed to analyse the effect of various demographic, socio-economic and life style variables for predisposing the individuals to various adiposity related morbidity based on WHR (Table 3.50). The outcome variables are being at risk of higher WHR and not at risk which was mark off by WHO (2008) cut-off for WHR. The demographic, socio-economic and life style variables were same as in previous cases.

The logistic regression analyses result of being at risk of high WHR was significantly ($p<0.05$) less likely for female with odd 0.21 (95% CI 0.08 – 0.56). The education level upto 8^{th} grade make individuals more prone to high WHR for which observed odds was 1.98 (95% CI 1.09 – 8.18) in the present study. The remaining odds values obtain were non-significant which are presented in Table 3.50.

Table 3.47: Results of Multinomial Logistic Regression analysis of being at the risk of underweight, overweight and obese vs. normal BMI (1995) by socio-economic and demographic variables among the Limboo individuals

	Underweight (vs. Normal)			Overweight (vs. Normal)			Obese (vs. Normal)		
	Wald	Odds	95 % CI	Wald	Odds	95 % CI	Wald	Odds	95% CI
Sex									
Male®		1			1			1	
Female	2.08	1.42	0.88-2.30	8.03	1.57**	1.15 - 2.14	9.80	3.11***	1.53 - 6.33
Age group									
18-29 years®		1			1			1	
30-49 years	6.36	0.48**	0.27-0.85	34.95	3.01***	2.09-4.33	9.70	3.94***	1.66-9.33
50-64 years	0.87	0.73	0.37-1.42	5.14	1.76*	1.08 - 2.87	7.22	3.89**	1.44-10.46
Marital status									
Unmarried®		1			1			1	
Married	0.26	1.15	0.67-1.97	25.94	3.27***	2.07-5.17	2.55	1.97	0.86-4.53
Education									
Illiterate®		1			1			1	
Upto 8^{th} grade	0.66	0.78	0.42-1.43	0.79	0.84	0.57-1.24	4.44	0.42*	0.19-0.94
≥ 9^{th} grade	0.20	0.87	0.47-1.60	1.39	0.79	0.53-1.17	1.99	0.58	0.27-1.24
Occupation									
Manual	0.80	1.40	0.67-2.91	14.60	4.64***	2.11-10.19	3.17	6.18	0.83-45.95
Non-manual	0.35	1.34	0.51-3.54	31.84	11.12***	4.82-25.67	6.51	14.76**	1.87-116.70
Others ®		1			1			1	
Income									
≤ ₹4999®		1			1			1	
₹5000 – ₹9999	1.17	1.65	0.67-4.08	0.31	0.85	0.49-1.49	0.64	1.86	0.41-8.45
≥ ₹10000	1.41	1.72	0.70-4.21	4.60	1.77*	1.05-2.97	2.99	3.62	0.84-15.57

	Underweight (vs. Normal)			Overweight (vs. Normal)			Obese (vs. Normal)		
	Wald	Odds	95 % CI	Wald	Odds	95 % CI	Wald	Odds	95% CI
Kuppuswamy SES									
Upper Middle (UM)	0.17	1.16	0.57-2.35	26.69	2.92***	1.94-4.38	9.05	3.38***	1.53-7.47
Lower Middle (LM)	0.33	1.17	0.69-2.00	6.92	1.62**	1.13-2.33	1.82	1.69	0.79-3.62
Upper Lower (UL)®		1			1			1	
Family size									
Small	0.21	1.12	0.68-1.85	0.01	0.98	0.71-1.37	0.04	1.07	0.55-2.10
Larger ®		1			1			1	
Land holding									
0 – 0.99 acre	0.30	0.87	0.52-1.45	0.97	0.85	0.61-1.18	0.02	1.05	0.54-2.06
≥ 1 acre ®		1			1			1	
House type									
Kacha	2.98	0.60	0.34-1.07	8.03	0.56**	0.38-0.84	1.68	0.56	0.24-1.34
Pakka	3.18	0.49	0.23-1.07	1.30	1.26	0.85- 1.86	1.28	1.54	0.73-3.28
Semi-Pakka®		1			1			1	
Drinking water									
Supply®		1			1			1	
Piped from spring	0.00	1.00	0.62-1.62	0.18	0.93	0.68-1.28	4.64	0.45*	0.22-0.93
Toilet									
Commode®		1			1			1	
Pit	1.97	0.56	0.25-1.26	3.39	0.63	0.39-1.03	2.89	0.29	0.07-1.21

® Reference; *p < 0.05; **p<0.001

Table 3.48: Result of Multinomial Logistic Regression analysis of being at risk of higher waist circumference (vs. Normal Waist Circumference) based on socio-economic and demographic variables among the Limboo individuals

Variables	Categories	High WC (vs. Normal)		
		Wald	Odds	95% CI
Sex	Male®		1	
	Female	209.39	11.81 ***	8.46 - 16.51
Age group	18-29 years®		1	
	30-49 years	17.44	1.86***	1.39 - 2.49
	50-64 years	4.01	1.48*	1.01 - 2.18
Marital status	Unmarried®		1	
	Married	25.52	2.39***	1.70 - 3.34
Education	Illiterate®		1	
	Upto 8th grade	15.57	0.51***	0.37 - 0.72
	≥ 9 grade	15.97	0.50***	0.36 - 0.71
Occupation	Manual	5.85	1.72*	1.11 - 2.67
	Non-manual	7.57	2.08**	1.23 - 3.50
	Others ®		1	
Income	≤ ₹4999®		1	
	₹5000 – ₹9999	1.89	1.39	0.87 - 2.22
	≥ ₹10000	5.71	1.74*	1.11 - 2.74
Kuppuswamy SES	Upper Middle (UM)	14.01	1.96***	1.38 - 2.79
	Lower Middle (LM)	0.06	1.04	0.77 - 1.40
	Upper Lower (UL)®		1	
Family size	Small	2.18	0.81	0.61 - 1.07
	Larger ®		1	
Land holding	0 – 0.99 acre	0.32	1.08	0.82 - 1.43
	≥ 1 acre ®		1	
House type	Kacha	7.13	0.64**	0.47 - 0.89
	Pakka	2.82	1.34	0.95 - 1.88
	Semi-Pakka®		1	
Drinking water	Supply®		1	
	Piped from spring	1.33	1.17	0.90 - 1.52
Toilet	Commode®		1	
	Pit	0.57	0.86	0.58 - 1.27

® Reference; *p < 0.05; **p<0.001

Table 3.49: Result of Multinomial Logistic Regression analysis of being at risk of higher WHtR (vs. Normal WHtR) based on socio-economic and demographic variables among the Limboo individuals

Variables	Categories	High WHtR (vs. Normal)		
		Wald	Odds	95% CI
Sex	Male®		1	
	Female	114.41	4.87***	3.64 - 6.50
Age group	18-29 years®		1	
	30-49 years	45.95	2.78***	2.07 - 3.73
	50-64 years	19.85	2.45***	1.65 - 3.63
Marital status	Unmarried®		1	
	Married	34.99	2.44***	1.81 - 3.27
Education	Illiterate®		1	
	Upto 8th grade	11.81	0.54***	0.38 - 0.77
	≥ 9 grade	11.60	0.53***	0.37 - 0.77
Occupation	Manual	9.55	1.84***	1.25 - 2.70
	Non-manual	16.80	2.88***	1.74 - 4.78
	Others ®		1	
Income	≤ ₹4999®		1	
	₹5000 – ₹9999	1.52	0.76	0.48 - 1.18
	≥ ₹10000	0.04	0.96	0.62 - 1.48
Kuppuswamy SES	Upper Middle (UM)	7.23	1.71*	1.16 - 2.52
	Lower Middle (LM)	0.00	1.00	0.74 - 1.34
	Upper Lower (UL)®		1	
Family size	Small	0.03	0.98	0.74 - 1.29
	Larger ®		1	
Land holding	0 – 0.99 acre	0.39	1.09	0.83 - 1.45
	≥ 1 acre ®		1	
House type	Kacha	1.74	0.82	0.60 - 1.10
	Pakka	5.28	1.55*	1.07 - 2.26
	Semi-Pakka®		1	
Drinking Water	Supply®		1	
	Piped from spring	0.35	1.08	0.83 - 1.42
Toilet	Commode®		1	
	Pit	4.42	0.67*	0.46 - 0.97

® Reference; *p < 0.05; **p<0.001

Table 3.50: Result of Multinomial Logistic Regression analysis of being at higher Waist Hip Ratio (WHR) (vs. Normal WHR) based on socio-economic and demographic variables among the Limboo individuals

Variables	Categories	High WHR (vs. Normal)		
		Wald	Odds	95% CI
Sex	Male®		1	
	Female	9.87	0.21***	0.08 - 0.56
Age group	18-29 years®		1	
	30-49 years	1.87	1.85	0.77 - 4.46
	50-64 years	0.01	0.96	0.36 - 2.53
Marital status	Unmarried®		1	
	Married	0.80	1.45	0.65 - 3.24
Education	Illiterate®		1	
	Upto 8th grade	4.52	2.98*	1.09 -8.18
	≥ 9 grade	0.85	1.49	0.64 - 3.50
Occupation	Manual	0.07	1.16	0.39 - 3.46
	Non-manual	0.12	1.29	0.32 - 5.25
	Others ®		1	
Income	≤ ₹4999®		1	
	₹5000 – ₹9999	0.03	0.90	0.25 - 3.28
	≥ ₹10000	0.01	0.94	0.27 - 3.33
Kuppuswamy SES	Upper Middle (UM)	0.17	0.82	0.32 - 2.14
	Lower Middle (LM)	0.24	1.25	0.51 - 3.11
	Upper Lower (UL)®		1	
Family size	Small	0.42	0.78	0.36 - 1.67
	Larger ®		1	
Land holding	0 – 0.99 acre	0.01	1.03	0.46 - 2.31
	≥ 1 acre ®		1	
House type	Kacha	1.31	0.61	0.27 - 1.42
	Pakka	0.07	0.87	0.31 - 2.47
	Semi-Pakka®		1	
Drinking Water	Supply®		1	
	Piped from spring	1.97	1.81	0.79 - 4.15
Toilet	Commode®		1	
	Pit	0.02	0.94	0.32 - 2.74

® Reference; *p < 0.05; **p<0.001

3.5 THE ROC-AUC ANALYSES OF DIFFERENT ADIPOSITY INDICES AMONG LIMBOO INDIVIDUALS WITH REFERENCE TO PBF AND BMI (WHO 2000).

3.5.1 ROC-AUC ANALYSIS USING PBF (25/30) AS REFERENCE.

The diagnostic properties of NC, WC, BMI, BAI, WHtR, WHR, and CI in detecting excess body fat given by AUC derived using PBF cut-offs of 25% for male and 30% for female Limboo individuals as reference is presented in Table 3.51 and 3.52, respectively. According to AUC of ROC-AUC analysis BMI (AUC 0.95), WC (AUC 0.94) and WHtR (AUC 0.94) were better predictors of excess adiposity than NC (AUC 0.93), BAI (AUC 0.90) WHR (AUC 0.86) and CI (AUC 0.80) among male Limboo individuals. Similarly, among the female Limboo individuals BMI (AUC 0.94), WC (AUC 0.92) and WHtR (AUC 0.90) were better predictors of excess adiposity compared to NC (AUC 0.87), BAI (AUC 0.87) WHR (AUC 0.73) and CI (AUC 0.71). The ROC-AUC plots are presented in the Figure 3.44a to 3.44n. The cut-offs given by ROC-AUC analysis based on PBF were 36.95 cm and 27.38 % respectively for NC and BAI among male Limboo individuals. The cut-offs observed for NC and BAI among female Limboo individuals were 36.65 cm and 35.35 %. The cut-offs decided for WC, WHtR, WHR, CI were different than the recommended cut-offs, yet observed closer to the obtain values among both males and females of the present study. The respective sensitivity and specificity is also provided in the respective Tables (Table 3.51 and Table 3.52).

Table 3.51: Diagnostic properties of anthropometric indicators of adiposity to detect high percentage body fat (PBF) among the male Limboo individuals

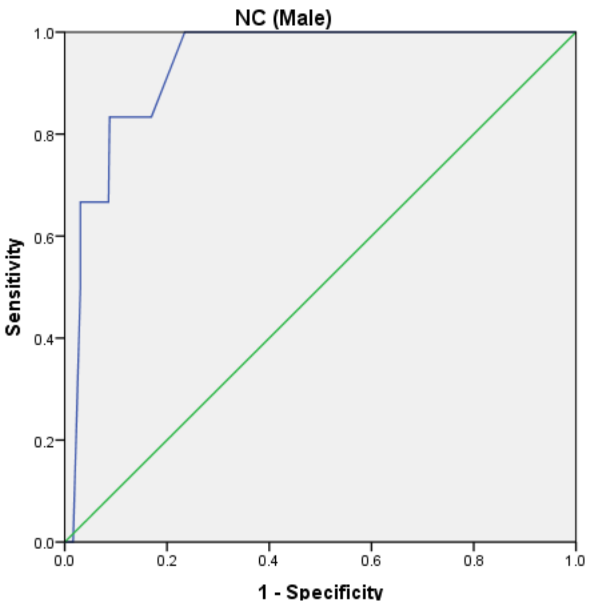
Index	AUC (CI 95%)	p-value	Cut-off	Sensitivity	Specificity
NC	0.93 (0.88-0.99)	.000	36.95	99	77
WC	0.94 (0.89-0.99)	.000	86.90	99	83
BMI	0.95 (0.91-0.99)	.000	26.11	99	87
BAI	0.90 (0.81-0.99)	.000	27.38	99	71
WHtR	0.94 (0.89-0.99)	.000	00.54	99	82
WHR	0.86 (0.79-0.93)	.000	00.93	99	71
CI	0.80 (0.68-0.91)	.000	1.26	83	71

Reference rang used for PBF is 25% for male and 30% for female.

Table 3.52: Diagnostic properties of anthropometric indicators of adiposity to detect high percentage body fat (PBF) among the female Limboo individuals

Index	AUC (CI 95%)	p-value	Cut-off	Sensitivity	Specificity
NC	0.87 (0.83-0.92)	.000	36.65	68	90
WC	0.92 (0.89-0.95)	.000	88.10	89	79
BMI	0.94 (0.92-0.97)	.000	26.16	86	88
BAI	0.87 (0.82-0.91)	.000	35.35	68	90
WHtR	0.90 (0.86-0.93)	.000	00.60	86	81
WHR	0.73 (0.66-0.80)	.000	00.95	74	67
CI	0.71 (0.64-0.78)	.000	1.31	86	60

Reference rang used for PBF is 25% for male and 30% for female.



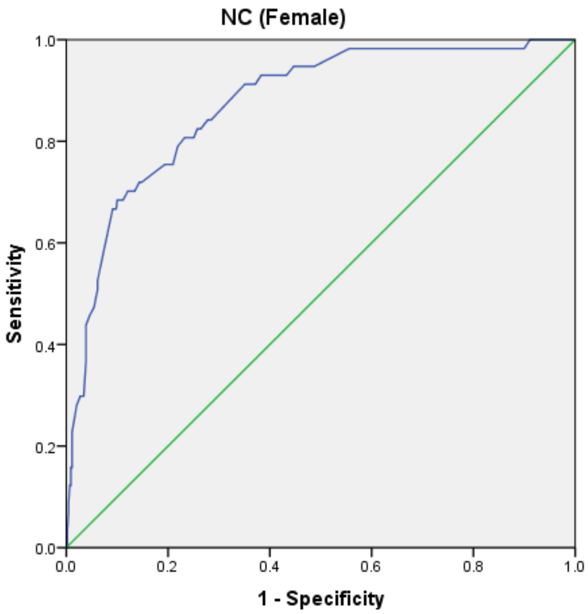


Figure 3.44a & 3.44b: ROC curve analysis for WC among male and female Limboo individuals (25% and 30% for male and female as reference).

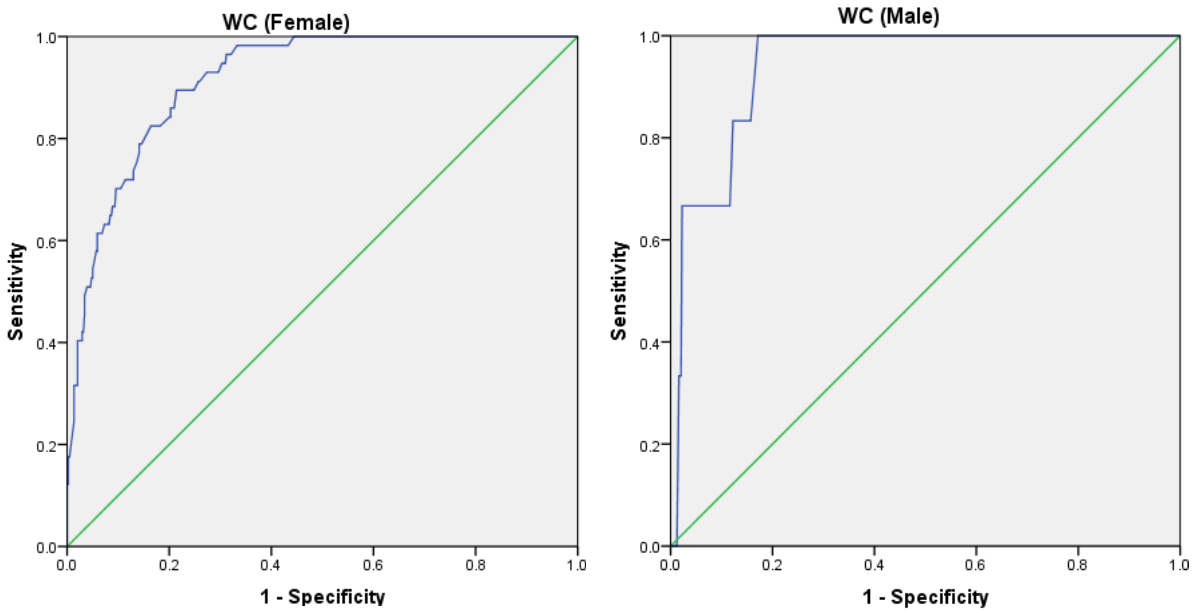


Figure 3.44c & 3.44d: ROC curve analysis for WC among male and female Limboo individuals (25% and 30% for male and female as reference).

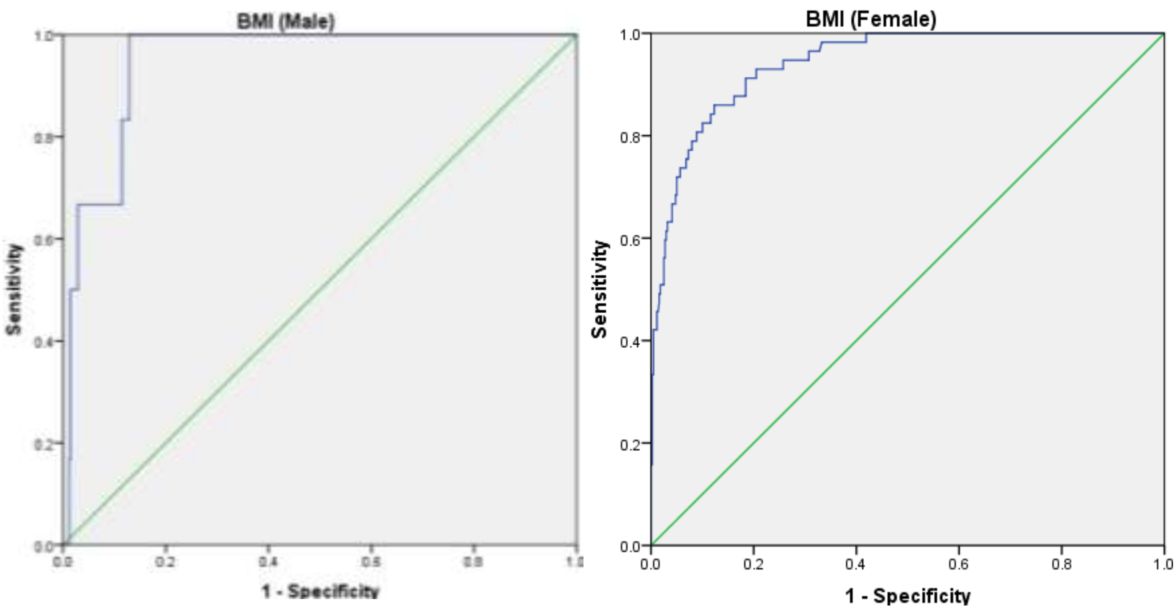


Figure 3.44e & 3.44f: ROC curve analysis for BMI among male and female Limboo individuals (25% and 30% for male and female as reference).

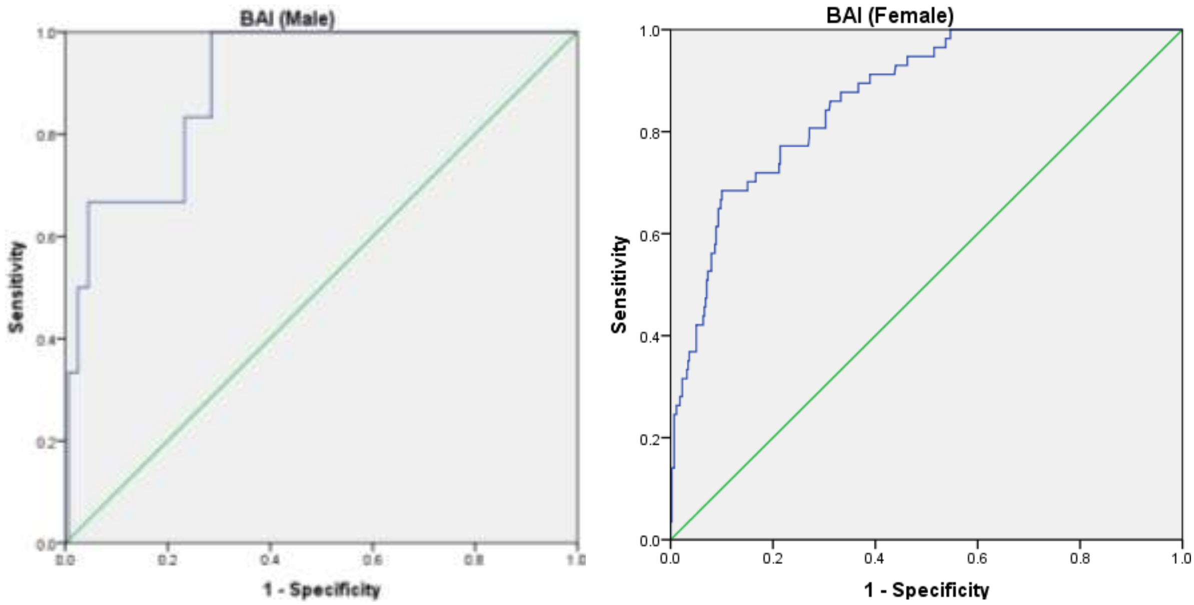


Figure 3.44g & 3.44h: ROC curve analysis for BAI among male and female Limboo individuals (25% and 30% for male and female as reference).

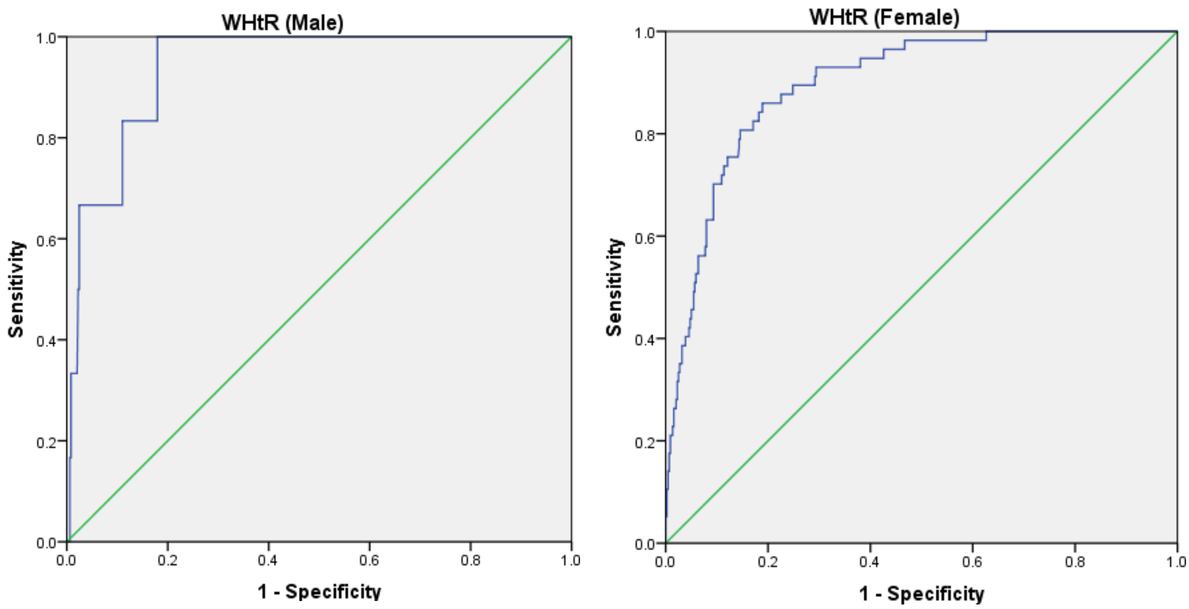


Figure 3.44i & 3.44j: ROC curve analysis for WHtR among male and female Limboo individuals (25% and 30% for male and female as reference).

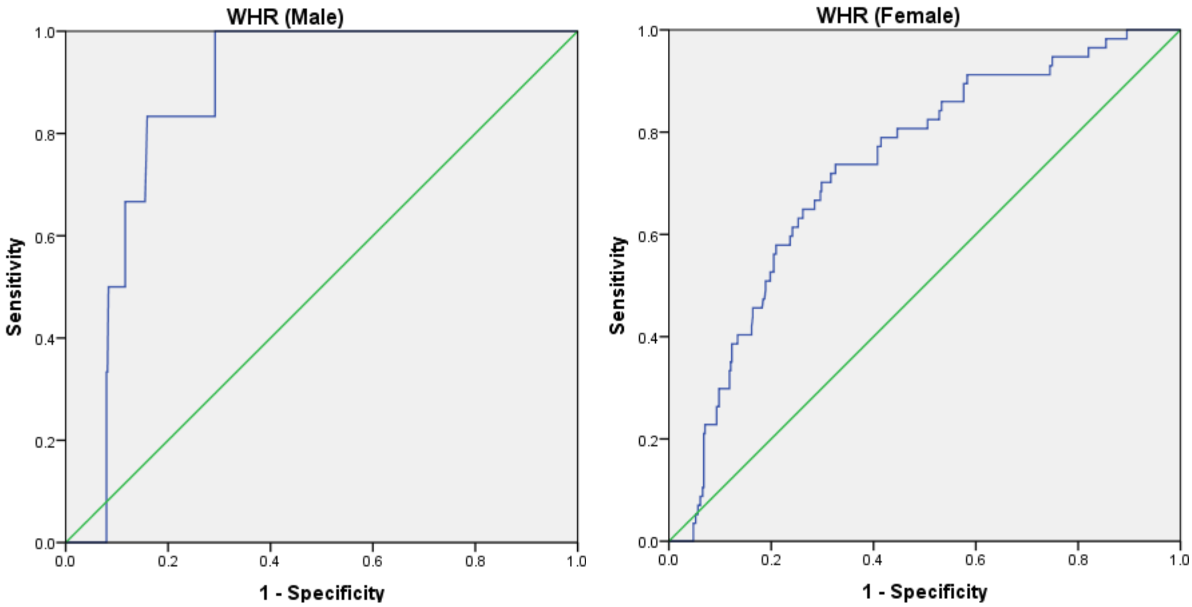


Figure 3.44k & 3.44l: ROC curve analysis for WHR among male and female Limboo individuals (25% and 30% for male and female as reference).

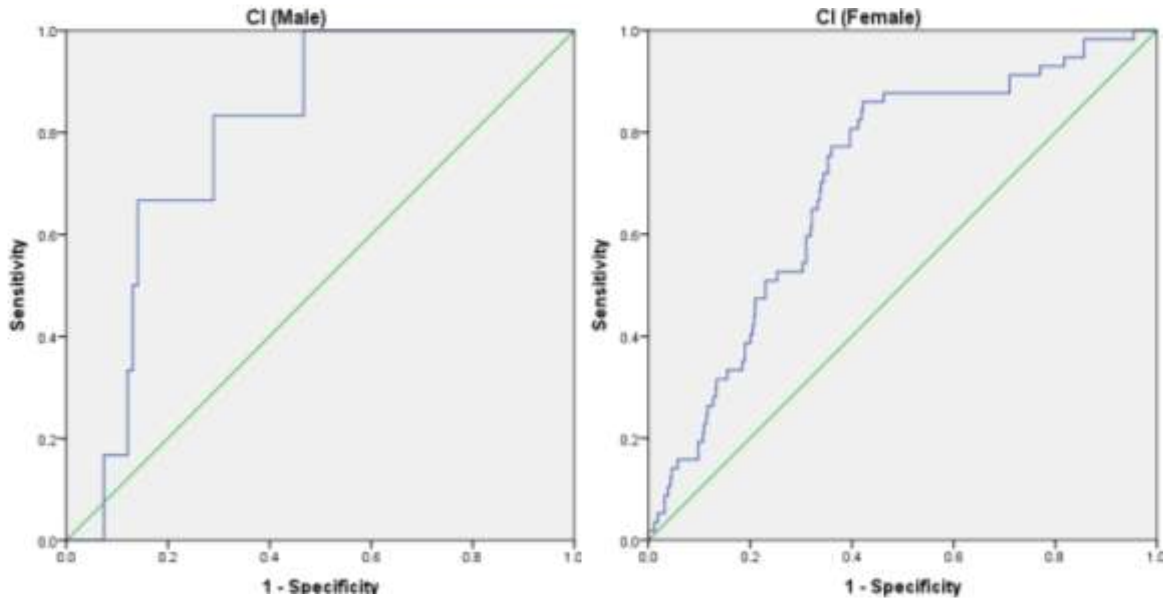


Figure 3.44m & 3.44n: ROC curve analysis for CI among male and female Limboo individuals (25% and 30% for male and female as reference).

3.5.2 THE ROC-AUC ANALYSES OF DIFFERENT ADIPOSITY INDICES AMONG LIMBOO INDIVIDUALS OF SIKKIM WITH REFERENCE TO BMI (WHO 2000) CRITERIA.

3.5.2.1 ROC-AUC Analysis using BMI 23 kgm^2 (WHO, 2000) as reference.

The diagnostic properties of NC, WC, BAI, WHtR, WHR, and CI for detecting high BMI >23 kgm^2 for male and female Limboo individuals are presented in Table 3.53 and 3.54, respectively. According to AUC analysis WHtR (AUC 0.93) and WC (AUC 0.92) were better predictors of high adiposity followed by BAI (AUC 0.89), NC (AUC 0.87), WHR (AUC 0.76), and CI (AUC 0.63) among male Limboo individuals. According to observed AUC, WHtR (AUC 0.91), BAI (AUC 0.91) WC (AUC 0.90) were followed by NC (AUC 0.88), WHR (AUC 0.70) and CI (AUC 0.65) among the female Limboo individuals. The respective plots of ROC-AUC are given in Figure 3.45a to 3.45l. The cut-offs estimated based on BMI > 23 kgm^2 were 35.55 cm and 25.68 % for NC and BAI respectively among male Limboo individuals using ROC-AUC analysis. Similarly, the observed cut-offs for NC and BAI among females were 31.70 cm and 30.90 %. The cut-offs decided for WC, WHtR, WHR, CI were observed closer to recommended cut-off among both males and females of present study. The respective sensitivity and specificity is presented in the respective tables.

Table 3.53: Diagnostic properties of anthropometric indicators of adiposity to detect BMI above 23 kgm^2 among adult male Limboo individuals

Index	AUC (CI 95%)	p-value	Cut-off	Sensitivity	Specificity
NC	0.87 (0.84-0.91)	.000	35.55	85	85
WC	0.92 (0.90-0.95)	.000	81.55	80	88
BAI	0.89 (0.86-0.92)	.000	25.68	89	77
WHtR	0.93 (0.91-0.96)	.000	00.51	85	89
WHR	0.76 (0.72-0.80)	.000	00.91	75	64
CI	0.63 (0.58-0.68)	.000	1.22	75	53

Reference rang used was BMI above 23 kg/m^2.

Table 3.54: Diagnostic properties of anthropometric indicators of adiposity to detect BMI above 23 kgm^2 among adult female Limboo individuals

Index	AUC (CI 95%)	p-value	Cut-off	Sensitivity	Specificity
NC	0.88 (0.86-0.91)	.000	31.70	75	85
WC	0.90 (0.87-0.93)	.000	82.90	83	84
BAI	0.91 (0.88-0.93)	.000	30.90	90	75
WHtR	0.91 (0.88-0.93)	.000	00.56	81	87
WHR	0.70 (0.65-0.74)	.000	00.90	81	53
CI	0.65 (0.60-0.70)	.000	1.29	71	57

Reference rang used was BMI above 23 kg/m^2.

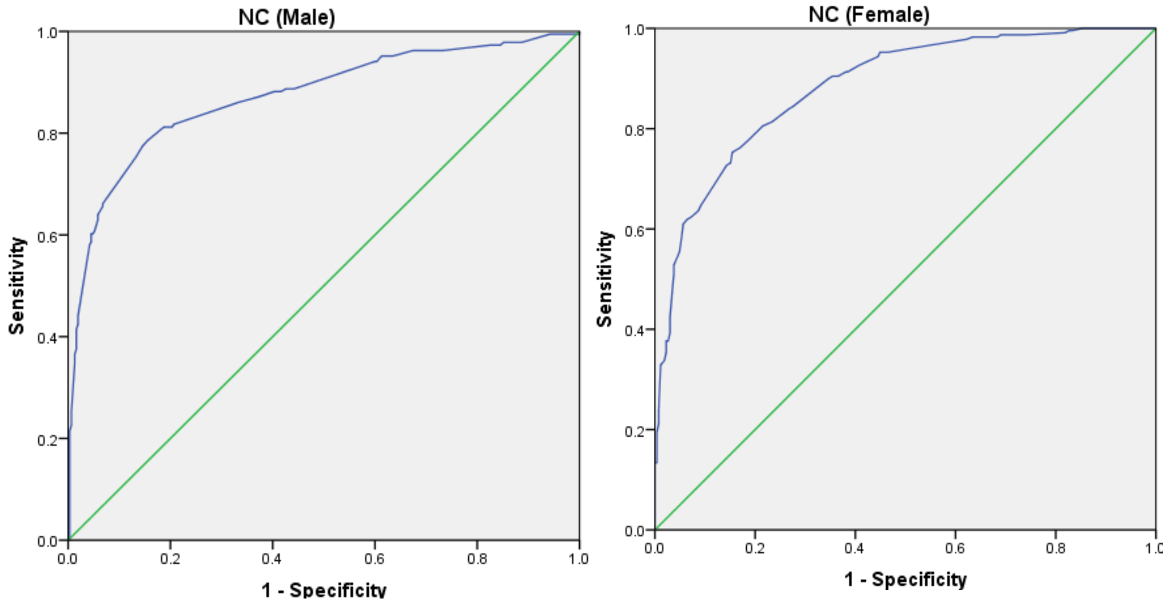


Figure 3.45a & 3.45b: ROC curve analysis for NC among male and female Limboo individuals (23 kg/m^2 as reference).

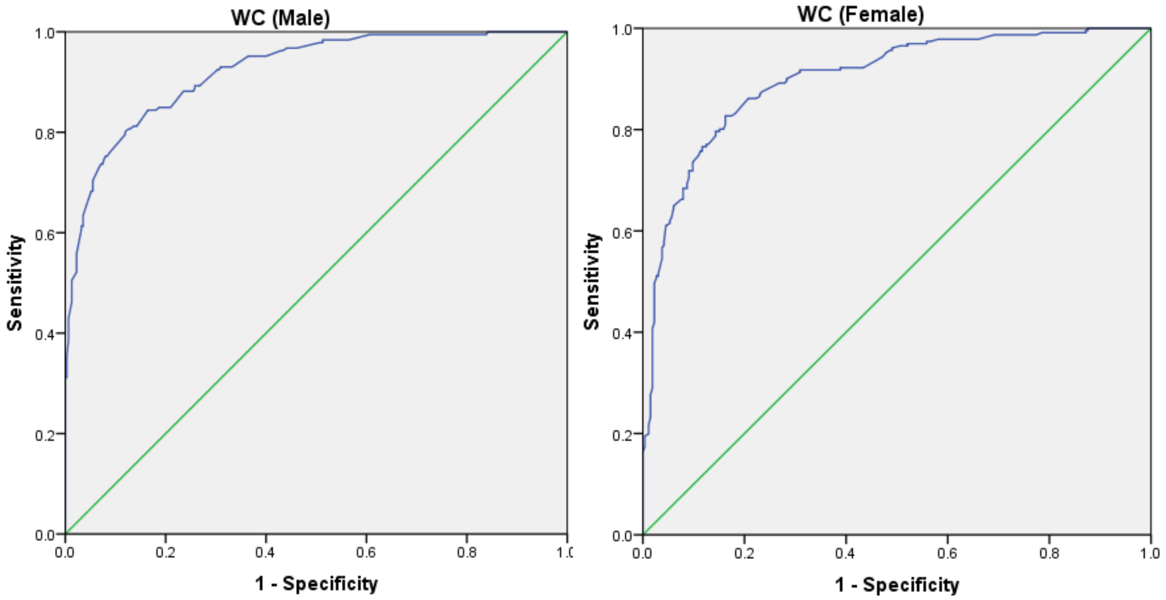


Figure 3.45c & 3.45d: ROC curve analysis for WC among male and female Limboo individuals (23 kg/m^2 as reference).

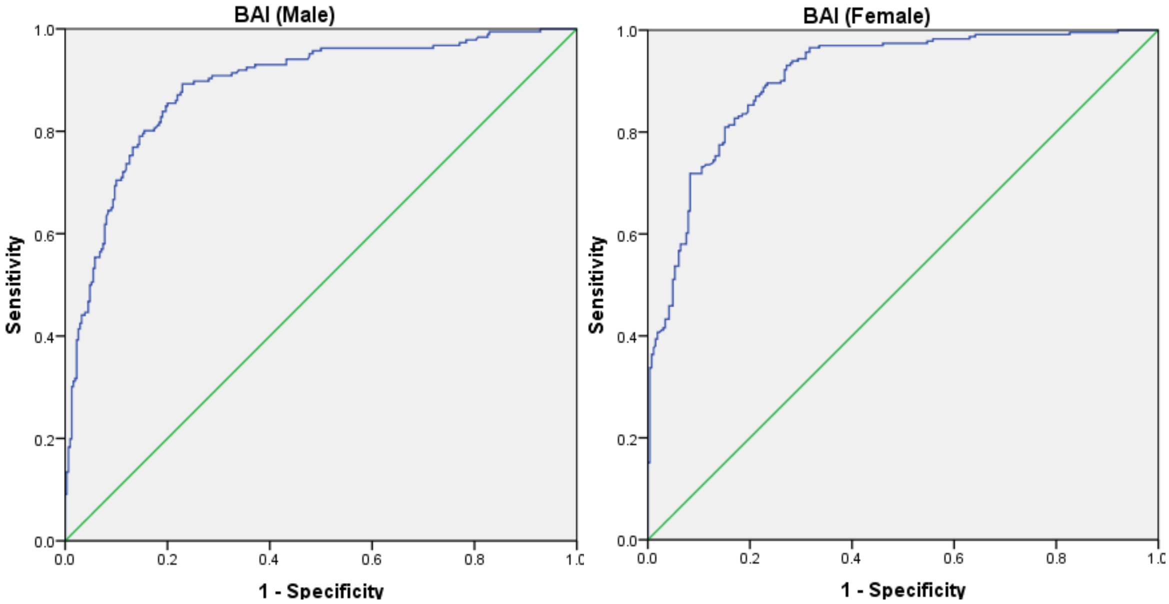


Figure 3.45e & 3.45f: ROC curve analysis for BAI among male and female Limboo individuals (23 kg/m^2 as reference).

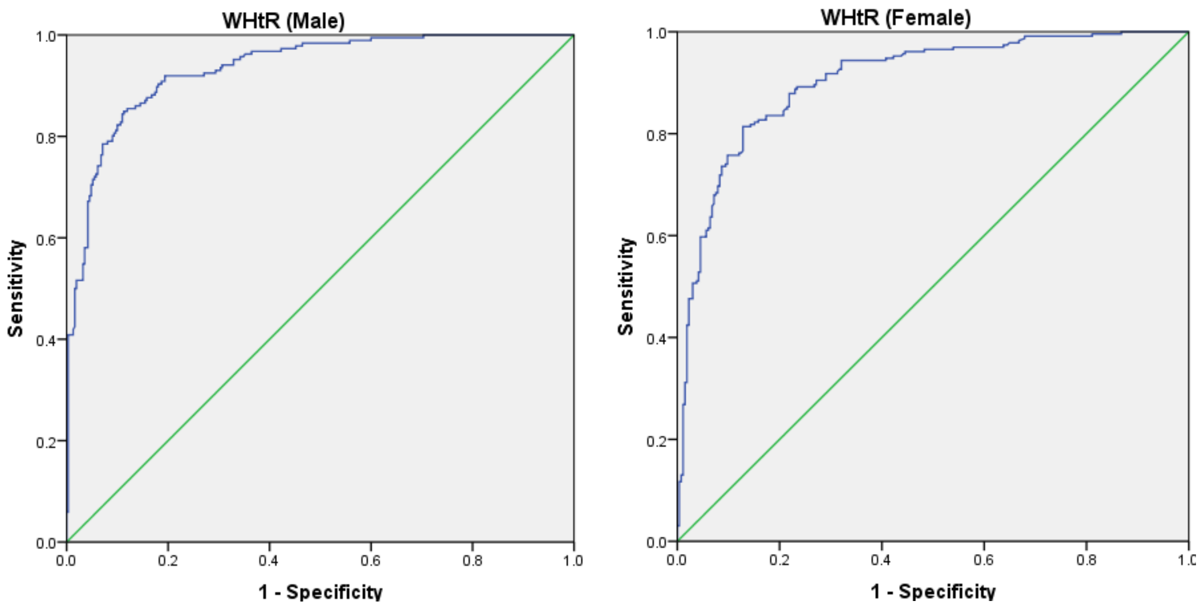


Figure 3.45g & 3.45h: ROC curve analysis for WHtR among male and female Limboo individuals (23 kg/m^2 as reference).

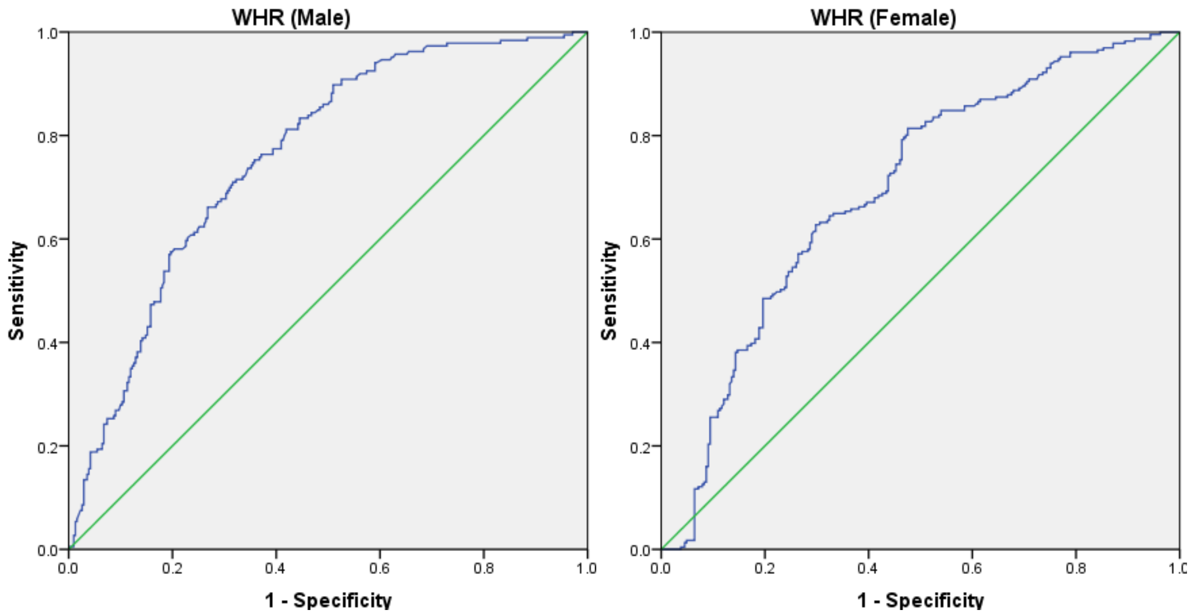
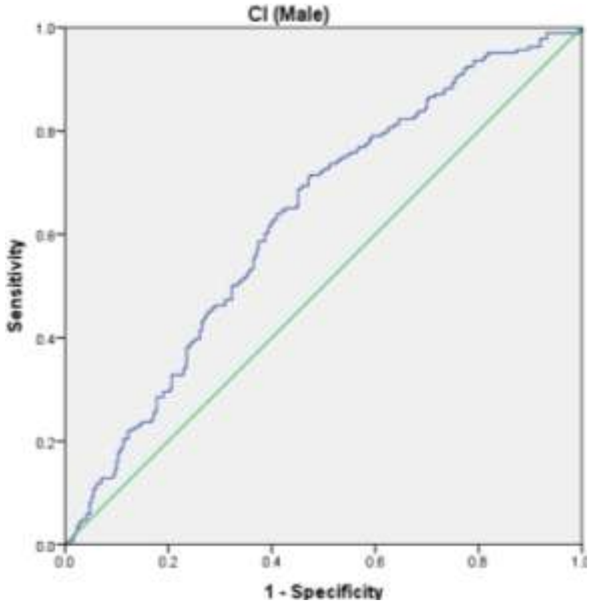


Figure 3.45i & 3.45j: ROC curve analysis for WHR among male and female Limboo individuals (23 kg/m^2 as reference).



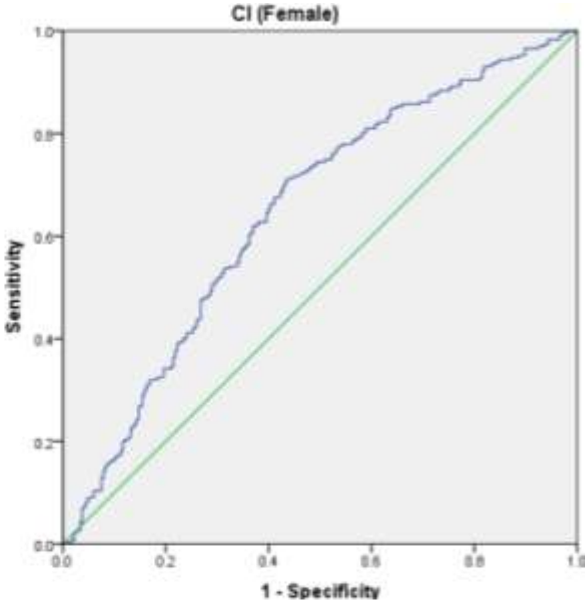


Figure 3.45k & 3.45l: ROC curve analysis for CI among male and female Limboo individuals (23 kg/m^2 as reference).

3.5.2.2 ROC-AUC Analysis using BMI 30 kgm^2 (WHO, 2000) as reference.

The diagnostic properties of NC, WC, BAI, WHtR, WHR, and CI in detecting excess adiposity with respective AUC derived with reference to BMI above 30 kg/m^2 among male and female Limboo individuals are presented in Table 3.55 and 3.56, respectively. According to AUC analysis WHtR (AUC 0.95) and WC (AUC 0.92) were observed as better predictors of excess adiposity followed by BAI (AUC 0.87), WHR (AUC 0.84), NC (AUC 0.81), and CI (AUC 0.68) among male Limboo individuals using BMI 30 kg/m^2 as reference. Among female it was BAI (AUC 0.98), WHtR (AUC 0.97), WC (AUC 0.96), followed by NC (AUC 0.93), WHR (AUC 0.79) and CI (AUC 0.77). The plot of ROC-AUC analysis is shown in Figure 3.46a to 3.46l. Among male and female Limboo individuals cut-offs obtained using ROC-AUC analysis were 38.25 cm and 33.15 cm for NC and 30.93% and 35.90% for BAI respectively. Interestingly, among the female Limboo individuals BAI (AUC 0.87) was observed as best indicator of adiposity with reference to BMI 30 kg/m^2 followed by WHtR (AUC 0.97), WC (AUC 0.96), NC (AUC 0.93), WHR (AUC 0.79) and CI (AUC 0.77). The cut-offs decided for WC, WHtR, WHR, C-Index were different than the recommended cut-offs yet observed closer to the obtain values among both males and females of present study. The respective sensitivity and specificity is also provided in the respective tables.

Table 3.55: Diagnostic properties of anthropometric indicators of adiposity to detect BMI above 30 kgm^2 among adult male Limboo individuals

Index	AUC (CI 95%)	p-value	Cut-off	Sensitivity	Specificity
NC	0.81 (0.61-0.99)	.000	38.25	80	92
WC	0.92 (0.83-0.99)	.000	93.50	80	96
BAI	0.87 (0.70-0.99)	.000	30.93	80	96
WHtR	0.95 (0.88-0.99)	.000	0.58	90	93
WHR	0.84 (0.73-0.96)	.000	0.95	80	83
CI	0.68 (0.50-0.87)	.000	1.27	60	79

Reference rang used was BMI above 30 kg/m^2.

Table 3.56: Diagnostic properties of anthropometric indicators of adiposity to detect BMI above 30 kgm^2 among adult female Limboo individuals

Index	AUC (CI 95%)	p-value	Cut-off	Sensitivity	Specificity
NC	0.93 (0.89-0.96)	.000	33.15	90	83
WC	0.96 (0.94-0.99)	.000	98.10	90	96
BAI	0.98 (0.95-0.98)	.000	35.90	97	90
WHtR	0.97 (0.95-0.99)	.000	0.65	93	94
WHR	0.79 (0.70-0.87)	.000	0.95	83	69
CI	0.77 (0.68-0.86)	.000	1.33	83	67

Reference rang used was BMI above 30 kg/m^2.

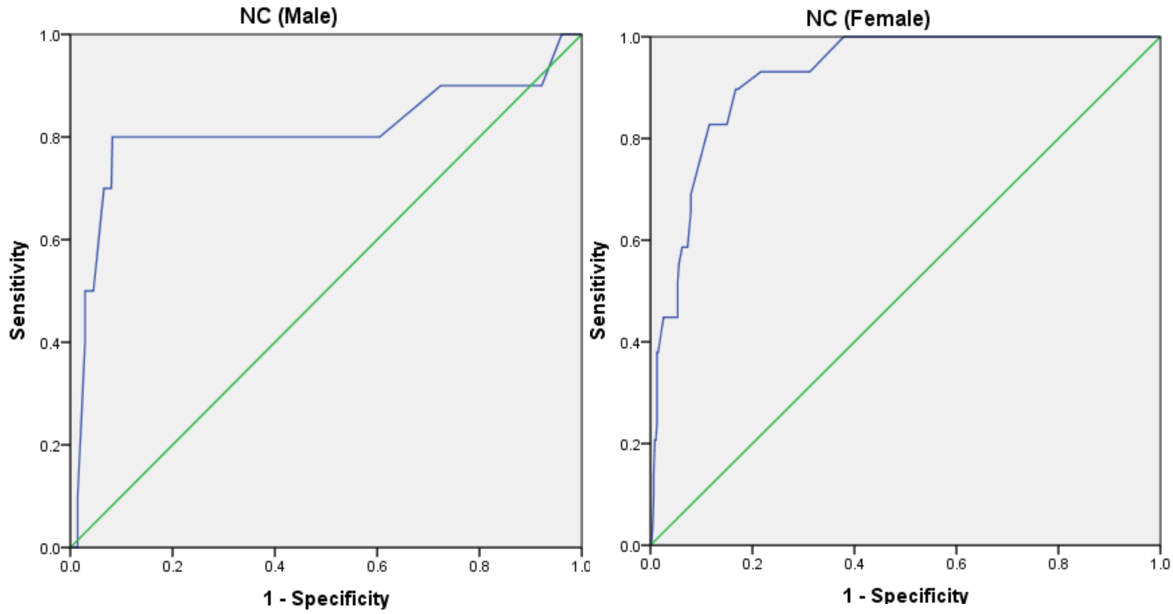


Figure 3.46a & 3.46b: ROC curve analysis for NC among male and female Limboo individuals (30 kg/m^2 as reference).

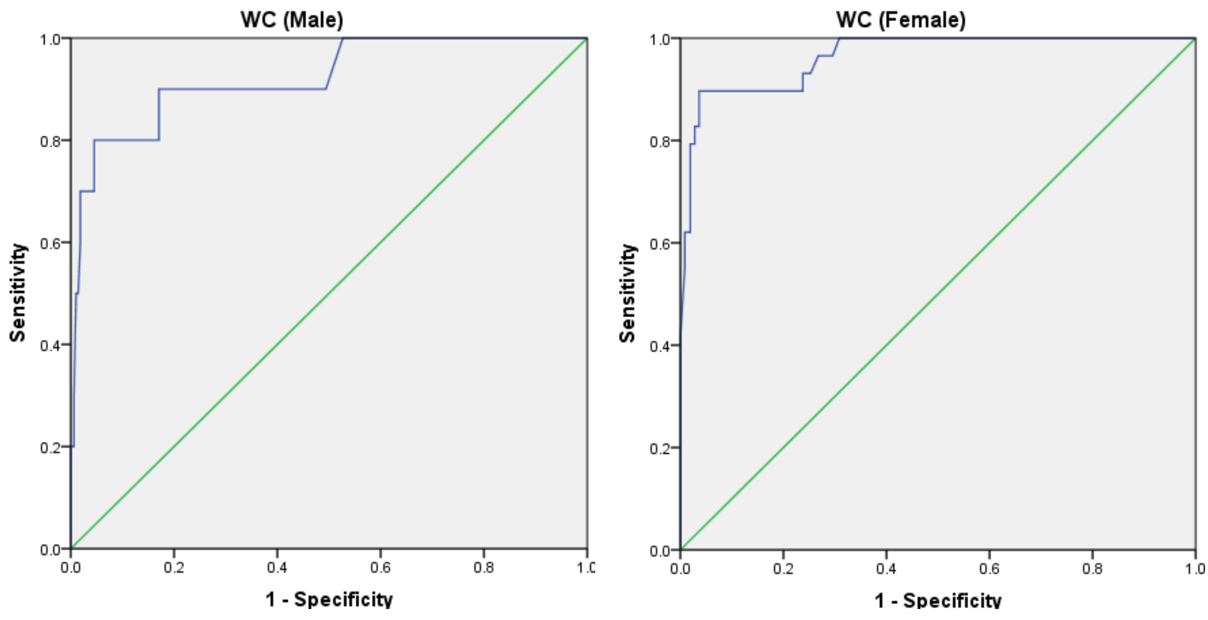


Figure 3.46c & 3.46d: ROC curve analysis for WC among male and female Limboo individuals (30 kg/m^2 as reference).

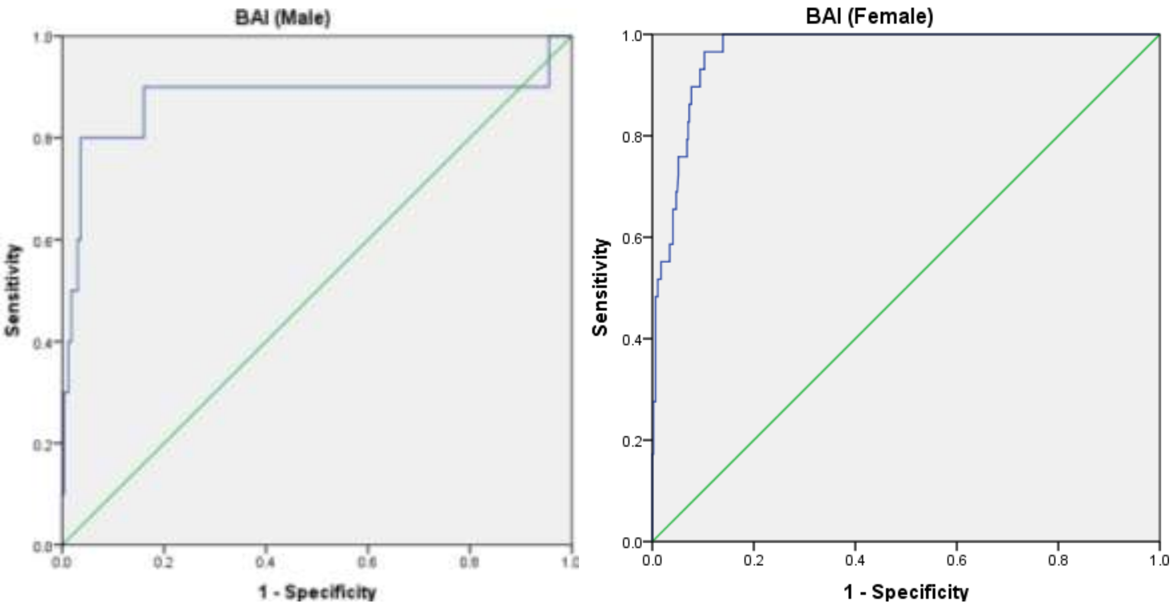


Figure 3.46e & 3.46f: ROC curve analysis for BAI among male and female Limboo individuals (30 kg/m^2 as reference).

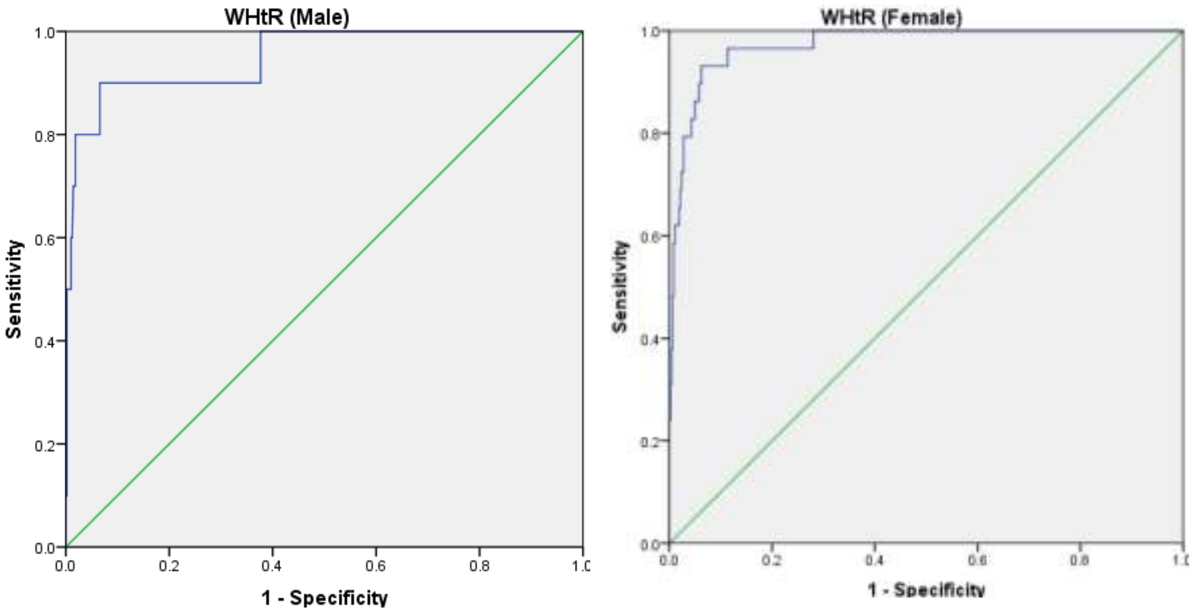


Figure 3.46g & 3.46h: ROC curve analysis for WHtR among male and female Limboo individuals (30 kg/m^2 as reference).

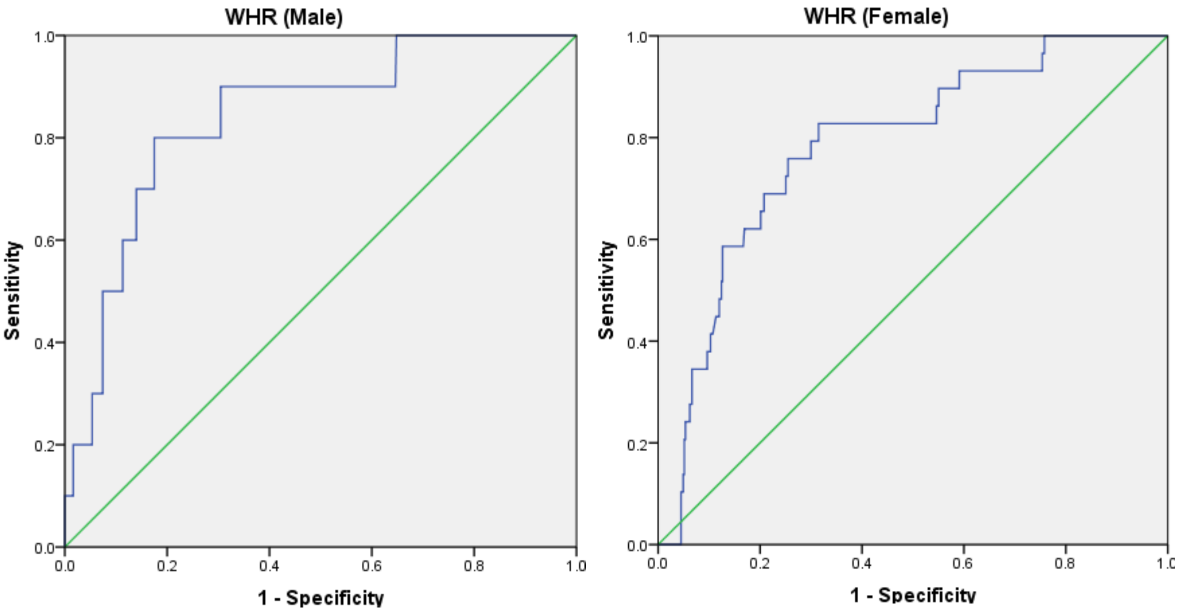


Figure 3.46i & 3.46j: ROC curve analysis for WHR among male and female Limboo individuals (30 kg/m^2 as reference).

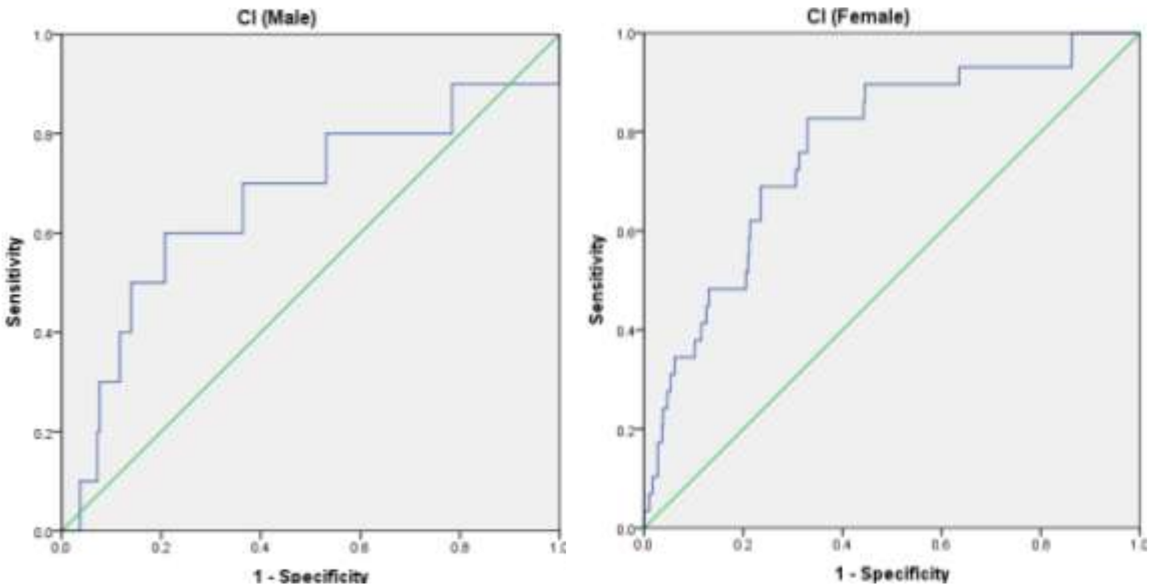


Figure 3.46k & 3.46l: ROC curve analysis for CI among male and female Limboo individuals (30 kg/m^2 as reference).