Results
4. RESULTS

The dynamics of growth processes maintain a harmonious relationship with the individual as a whole inspite of differential rate of growth in various body segments. The extent of growth varies from individual to individual. Different children grow at different rate and time. It is not a uniform process of increase and often one part of the body appears to be quite out of step with another during their growth periods. In order to evaluate the patterns of physical growth and nutritional status present study was conducted on Garhwali and Jaunsari Rajput females (age range 8 to 18 years), of district Dehradun, Uttarakhand. A total of 22 somatometric measurements have been cross sectionally obtained on a total of 1319 females (664 Garhwali and 655 Jaunsari) in accordance with the techniques recommended by Weiner and Lourie 1969. As described by most researchers that the intensity of human growth is maximum during adolescent period and is marked by accelerated rate of growth in all body dimensions. The spurt in different body dimensions that occur during this phase of life is commonly referred to as “adolescent growth spurt”. Intensity of growth spurt and its period of occurrence varies from one child to another.

The data collected in the present study were subjected to statistical treatment and the results are compiled and represented in the form of tables and graphical illustrations. The tables reveals mean, standard deviation, standard error of mean and t-test to assess population differences, if any, between means of both the group of females under study besides annual increments (rate of growth per year). Deceleration in the annual increase has been observed for different body dimensions in present study which may be due to cross sectional nature of data. The tables also incorporate the age wise percentile value for Height, Body weight, Waist hip ratio (WHR) and Body Mass Index (BMI) at 3rd, 10th, 25th, 50th, 75th, 90th and 97th levels. Graphic illustrations have been plotted using mean values against each age point to construct the “distance curves”, to exhibit the amount of growth achieved by different body dimensions for both Garhwali and Jaunsari Rajput females. “Velocity curves” are also plotted to observe the changes in the rate of growth per year. Despite the fact that Tanner (1978) suggested not to plot velocity curves on the cross sectional data,
because they do not reveal the exact velocity. Regression equation with correlation is also used for analysis with inter relations amongst body measurements. The results derived statistically have been prepared and presented under the following headings:

4.1 Assessment of physical growth
   4.1.1 Gross body measurements
   4.1.2 Lengths
   4.1.3 Body widths
   4.1.4 Body circumferences
   4.1.5 Skinfold

4.2 Nutritional assessment
   4.2.1 Body Mass Index (BMI)
   4.2.2 Waist Hip Ratio (WHR)
   4.2.3 Percentile Calculation for Height, Body weight, BMI and WHR.

4.3 Comparison of BMI with WHO and NCHS BMI percentile standards.

4.4 Regression equations for all body measurements

4.1 Assessment of physical growth

Anthropometric measurements helps in assessing growth performance of preadolescent and adolescent Garhwali and Jaunsari females of Dehradun district, Uttrakhand.

4.1.1 Gross body measurements

4.1.1.1 Body weight

Table 4.1.1.1 presents the mean values and other statistical constants of body weight along with annual increase in body weight among Garhwali and Jaunsari Rajput females ranging in age from 8 to 18 years. It can be interpreted from the table that the Garhwali females show an increase in body weight from 27.27 kg at 8 years to maximum of 50.04 kg at 18 years. On the other hand, the Jaunsari females, exhibit 25.56 kg weight at 8 years and 48.23 kg at 18 years. It is evident that the Garhwali females are heavier than the Jaunsari females at all age groups, as also apparent from the distance curve plotted for body weight (Figure 4.1.1.1.a). It is evident that the
Garhwali and Jaunsari females exhibit an overall increase of 22.77 kg and 22.67 kg from 8 to 18 years respectively.

The Standard deviation which reflects the dispersion around the mean body weight varies from a minimum 2.89 kg at 10 years to maximum of 5.01 kg at 15 years among Garhwali females, while for Jaunsari females it ranges from a minimum of 2.14 kg at 16 years to maximum of 3.62 kg at 14 years expressing the extent of variance in body weight. High value of standard deviation at particular age during growth denotes greater individual variation. This variation may be due to differences in growth patterns at individual level.

The difference between the mean values of body weight was significant at all age groups. To evaluate the annual increase in body weight at different age groups from 8 to 18 years, differences between the preceding and succeeding age groups were obtained. It is observed that the rate of growth among Garhwali females varies from a minimum of 0.09 kg between 17-18 years to a maximum of 5.10 kg between 10-11 years, whereas among Jaunsari females it varies from a minimum of 0.25 kg between 14-15 years to a maximum of 6.59 kg between 11-12 years, as represented through the bar diagrams depicting annual increase (Figure 4.1.1.1 b). There is no such decline in mean values of these two populations

4.1.1.2 Height

The mean values and other statistical constants of height along with annual increase in height among Garhwali and Jaunsari Rajput females of 8 to 18 years of age are shown in table 4.1.1.2. The table shows that the Garhwali females exhibit an increase in height from 128.22 cm at 8 years to maximum of 155.67 cm at 18 years. In comparison, the Jaunsari females exhibit 126.87 cm height at 8 years and 152.62 cm at 18 years. It is evident from the distance curve plotted for height (Figure 4.1.1.2.a) that Garhwali females are taller than the Jaunsari females at all age groups. It is apparent that the Garhwali females exhibit an overall increase of 27.45 cm and Jaunsari females exhibit an overall increase of 25.75 cm from 8 to 18 years. Height of these two population group females was statistically significant at 8 to 12 and 18 years.
At particular age high value of standard deviation during growth denotes greater individual variation which may be due to the differences in growth patterns at individual level. It indicates the variation in height which reflects the dispersion around the mean height, which varies from a minimum 3.21 cm at 10 years to maximum of 4.75 cm at 12 years among Garhwali females and for Jaunsari females it ranges from a minimum of 2.89 cm at 8 years to maximum of 4.29 cm at 14 years.

The annual increase in height at different age groups is evaluated by studying the differences between the preceding and succeeding age groups of 8 to 18 years of age. It is observed that the rate of growth varies from a minimum of 0.22 cm between 14-15 years to a maximum of 5.71 cm between 10-11 years among Garhwali females whereas for Jaunsari females it ranges from a minimum of 0.09 cm between 17-18 years to a maximum of 7.87 cm between 11-12 years as represented through the bar diagram depicting annual increase with negligible decline (Figure 4.1.1.2.b).

4.1.2 Lengths

4.1.2.1 Sitting height

In Garhwali and Jaunsari Rajput females ranging in age from 8 to 18 years, the measures of central tendency and dispersion along with annual increase in sitting height is represented in table 4.1.2.1. It is observed from the table that among Garhwali females the sitting height increases from 65.03 cm at 8 years to maximum of 80.84 cm at 18 years. On the other hand, Jaunsari females exhibit 63.76 cm at 8 years and 80.12 cm at 18 years. It is apparent that in the age group of 8 to 18 years, the Garhwali females have higher sitting height than the Jaunsari females, which is also indicated by the distance curve plotted for sitting height (Figure 4.1.2.1 a). Sitting height is significant at 8 to 10, 12 and 13 years. The Garhwali and Jaunsari females exhibit an overall increase of 15.81 cm and 16.36 cm from 8 to 18 years respectively.

Among Garhwali females the variation in sitting height, as indicated by standard deviation which reflects the dispersion around the mean sitting height varies from a minimum of 1.81 cm at 8 years to maximum of 2.99 cm at 12 years and it ranges from
a minimum of 1.95 cm at 16 years to maximum of 2.62 cm at 11 years among Jaunsari females. At a particular age during growth, standard deviation has a higher value, which denotes greater individual variation. This variation can be due to differences in growth patterns at individual level. Differences between the preceding and succeeding age groups were studied in different age groups from 8 to 18 years in sitting height. It is observed among Garhwali females that the rate of growth varies from a minimum of 0.16 cm between 17-18 years to a maximum of 3.32 cm between 11-12 years where as among Jaunsari females it varies from a minimum of 0.06 cm between 14-15 years to a maximum of 3.27 cm between 12-13 years which corresponds to the period of adolescent spurt in sitting height as represented through the bar diagram depicting annual increase with negligible decline in both Garhwali and Jaunsari females (Figure 4.1.2.1 b).

**4.1.2.2 Total Arm Length**

Total arm length of Garhwali females shows an increase from 54.01 cm at 8 years to maximum of 65.31 cm at 18 years. In case of Jaunsari females it increases from 52.10 cm at 8 years to maximum of 65.60 cm at 18 years with slight decline at 18 years (Table 4.1.2.2). It is evident that the Garhwali and Jaunsari females exhibit an overall increase of 11.30 cm and 13.50 cm respectively from 8 to 18 years of age, as shown in distance curve plotted for total arm length (Figure 4.1.2.2 a). The variation shown by the standard deviation which reflects the dispersion in the mean total arm length ranges from a minimum of 1.85 cm at 13 years to maximum of 3.14 cm at 10 years for Garhwali females and minimum of 1.64 cm at 10 years to maximum of 2.82 cm at 12 years for Jaunsari females. Individual variations which may be due to differences in growth patterns at individual level are responsible for higher value of standard deviation at particular age during growth.

On subjecting the data to test of significance, it is observed that apparent variation occurs at 8 to 10 years. To evaluate the annual increase in total arm length at different age groups from 8 to 18 years, differences between the preceding and succeeding age
groups were obtained. It is observed that the rate of growth among Garhwali females varies from a minimum of 0.04 cm between 17-18 years to a maximum of 2.62 cm between 10-11 years whereas among Jaunsari females it varies from a minimum 0.15 cm at 18 years to maximum of 3.78 cm at 12 years with negligible registered decline, which corresponds to the period of adolescent spurt in total arm length as represented through the bar diagram depicting annual increase (Figure 4.1.2.2 b).

4.1.2.3 Upper arm length

The measures of central tendency and dispersion along with annual increase in Upper Arm Length among Garhwali and Jaunsari Rajput females ranging in age from 8 to 18 years is elucidated in table 4.1.2.3. It is observed from the table that the Garhwali female exhibit an increase in upper arm length from 21.19 cm at 8 years to maximum of 26.59 cm at 17 years with slight decline at 15 and 18 years. On the other hand, Jaunsari females exhibit 20.41 cm at 8 years and 26.65 cm at 18 years, as shown in distance curve plotted for upper arm length (Figure 4.1.2.3 a). It is also evident that the Garhwali and Jaunsari females exhibit an overall increase of 4.48 cm and 6.52 cm respectively from 8 to 18 years. The ‘t’ test reveals that upper arm length is significant at 8 to 10 and 12 years.

In upper arm length the variation results from differences in growth patterns at individual level denotes due to High value of standard deviation at particular age during growth as indicated by standard deviation which reflects the dispersion around the mean upper arm length varies from a minimum 0.83 cm at 17 years to maximum of 1.40 cm at 11 years among Garhwali females, while for Jaunsari females it ranges from a minimum of 0.71 cm at 10 years to maximum of 1.53 cm at 13 years expressing the extent of variance.

Difference between the former and later age groups is obtained to assess the annual increase in upper arm length at different age groups from 8 to 18 years. It is observed that the rate of growth varies from a minimum of -0.11 cm between 17-18 years to a maximum of 1.29 cm between 11-12 years with a decline of -0.03 cm at 14 years.
among Garhwali females and from a minimum of 0.12 cm between 14-15 years and between 16-17 years to a maximum of 1.10 cm between 11-12 years among Jaunsari females, which is shown in the bar diagram depicting annual increase (Figure 4.1.2.3 b) corresponding to the period of adolescent spurt in upper arm length.

4.1.2.4 Fore arm length

For Garhwali and Jaunsari Rajput females ranging in age from 8 to 18 years, table 4.1.2.4 explains the mean values and other statistical constants along with annual increase in forearm length. It is observed from the table that the Garhwali female forearm’s length increases from 19.60 cm at 8 years to maximum of 24.34 cm at 17 years with slight decline at 18 years. On the other hand Jaunsari females exhibit 18.64 cm at 8 years to maximum of 24.43 cm at 17 years with slight decline at 14, 16 and 18 years as shown in distance curve plotted for fore arm length (Figure 4.1.2.4 a). It is evident that the Garhwali and Jaunsari females exhibit an overall increase of 4.26 cm and 5.75 cm from 8 to 18 years respectively.

Greater Individual variation denoted by high value of standard deviation at particular age group which may be due to differences in growth patterns at individual level. The standard deviation which reflects the dispersion around the mean forearm length varies from a minimum of 0.82 cm at 17 years to maximum of 1.55 cm at 10 years among Garhwali females, while for Jaunsari females it ranges from a minimum of 0.65 cm at 8 years to maximum of 1.27 cm at 13 years expressing the extent of variance in forearm length. The difference between the two groups in mean fore arm length was statistically significant at 8 to 14 and 18 years.

To evaluate the annual increase in forearm length at different age groups from 8 to 18 years, differences between the preceding and succeeding age groups were obtained. It is observed among Garhwali females that the rate of growth varies from a minimum of -0.34 cm between 17-18 years to a maximum of 1.24 cm between 11-12 years whereas in Jaunsari females it varies from a minimum of -0.22 cm between 15-16 years to a maximum of 1.18 cm between 12-13 years which corresponds to the period of adolescent spurt in fore arm length as represented through the bar diagram
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depicting annual increase (Figure 4.1.2.4 b) with a small decline at 18 years in Garhwali females whereas at 14, 16 and 18 years in Jaunsari females.

4.1.2.5 Hand length

The measures of central tendency and dispersion along with annual increase in hand length among Garhwali and Jaunsari Rajput females ranging in age from 8 to 18 years is illustrated in table 4.1.2.5. It can be interpreted from the table that the Garhwali females exhibit an increase in hand length from 13.12 cm at 8 years to maximum of 16.69 cm at 18 years. The Jaunsari females exhibit 12.15 cm at 8 years and 16.50 cm at 15 years with slight decline at 14, 16 and 18 years, as shown in distance curve plotted for hand length (Figure 4.1.2.5 a). It is evident that the Garhwali and Jaunsari females exhibit an overall increase of 3.57 cm and 4.35 cm respectively from 8 to 18 years.

The variation in hand length, as indicated by standard deviation which reflects the dispersion around the mean hand length among Garhwali females varies from a minimum 0.63 cm at 16 years to maximum of 0.93 cm at 12 years while for Jaunsari females it ranges from a minimum of 0.43 cm at 9 years to maximum of 0.96 cm at 12 years. High value of standard deviation at particular age during growth denotes greater individual variation. This variation may be due to differences in growth patterns at individual level.

Hand length is statistically significant at 8 to 11 and 13 years. Annual increase in hand length, assessed by calculating differences between the preceding and succeeding age groups was studied in different age groups from 8 to 18 years. It is observed that the rate of growth among Garhwali females varies from a minimum of 0.01 cm between 16-17 years to a maximum of 1.13 cm between 9-10 years whereas Jaunsari females exhibit a minimum value of -0.21 cm between 15-16 years to a maximum of 1.09 cm between 11-12 years which corresponds to the period of adolescent spurt in hand length as represented through the bar diagram depicting annual increase (Figure 4.1.2.5 b) with no decline among Garhwali but in Jaunsari females it occurs at 14, 16 and 18 years.
4.1.2.6 Lower leg length

Table 4.1.2.6 depicts the measures of central tendency and dispersion along with annual increase in lower leg length among Garhwali and Jaunsari Rajput females ranging in age from 8 to 18 years. It is observed from the table that the Garhwali females exhibit an increase in lower leg length from 26.50 cm at 8 years to maximum of 32.72 cm at 18 years. On the other hand Jaunsari females exhibit 25.09 cm at 8 years and 32.46 cm at 18 years as evident from the distance curve plotted for lower leg length (Figure 4.1.2.6 a). It is observed that the Garhwali and Jaunsari females exhibit an overall increase of 6.22 cm and 7.37 cm respectively from 8 to 18 years. The difference between the mean lower leg length of these two population females was statistically significant at 8,11,12 and 18 years.

High value of standard deviation at particular age during growth denotes greater individual variation which may be due to differences in growth patterns at individual level. Variation in lower leg length, as observed through standard deviation which reflects the dispersion around the mean lower leg length varies from a minimum 1.42 cm at 16 years to maximum of 2.06 cm at 10 years among Garhwali females while for Jaunsari it varies from a minimum 0.78 cm at 8 years to maximum of 2.70 cm at 13 years.

To evaluate the annual increase in lower leg length at different age groups from 8 to 18 years, differences between the preceding and succeeding age groups were obtained. It is observed that the rate of growth among Garhwali females varies from a minimum of -0.07 cm between 14-15 years to a maximum of 2.56 cm between 11-12 years whereas in case of Jaunsari females it varies from a minimum of -0.09 cm between 14-15 years to a maximum of 1.19 cm between 9-10 years, as evident from the bar diagram depicting annual increase (Figure 4.1.2.6 b) with a small decline at 15 years among both Garhwali and Jaunsari females.
4.1.2.7 Total lower extremity length

In Garhwali and Jaunsari Rajput females ranging in age from 8 to 18 years, the mean values and other statistical constants along with annual increase in total lower extremity length among are shown in Table 4.1.2.7. It is observed from the table that Garhwali females exhibit an increase in total lower extremity length from 67.20 cm at 8 years to maximum of 80.23 cm at 18 years among Garhwali females. On the other hand among Jaunsari females total lower extremity length increases from 64.68 cm at 8 years to maximum of 80.03 cm at 16 years as shown in distance curve plotted for total lower extremity length (Figure 4.1.2.7 a). Garhwali females exhibit an overall increase of 13.03 cm and Jaunsari females exhibit overall increase of 15.35 cm from 8 to 18 years. On subjecting the data to test of significance, it is observed that apparent variation occur at 8 to 10, 12, 13 and 16 years.

Variation in total lower extremity length, as indicated by standard deviation which reflects the dispersion around the mean total lower extremity length among Garhwali females varies from a minimum of 1.76 cm at 14 years to maximum of 2.47 cm at 8 years while for Jaunsari females it ranges from a minimum of 1.87 cm at 14 years to maximum of 2.75 cm at 11 years. Individual variations are responsible for higher value of standard deviation at particular age during growth. These variations may be due to differences in growth patterns at individual level.

In total lower extremity length annual increase is assessed through differences between the preceding and succeeding age groups from 8 to 18 years. It is observed that the rate of growth varies from a minimum of 0.09 cm between 8-9 years to a maximum of 2.95 cm between 11-12 years among Garhwali females whereas among Jaunsari females it varies from a decline of -0.24 cm between 16-17 years to a maximum of 5.75 cm between 12-13 years which corresponds to the period of adolescent spurt in total lower extremity length as represented through the bar diagram depicting annual increase (Figure 4.1.2.7 b) with small decline at 17 years.
4.1.2.8 Thigh length

Statistical constants and mean values along with annual increase in thigh length are represented in table 4.1.2.8 for Garhwali and Jaunsari Rajput females ranging in age from 8 to 18 years. It is observed from the table that Garhwali females exhibit an increase in thigh length from 35.57 cm at 8 years to maximum of 42.70 cm at 18 years with slight decline at 14 and 17 years. On the other hand, Jaunsari females exhibit 34.51 cm at 8 years and 42.63 cm at 18 years with slight decline at 14 years, as evident from the distance curve plotted for thigh length (Figure 4.1.2.8 a). It is observed that the Garhwali females exhibit an overall increase of 7.13 cm and Jaunsari females exhibit 8.12 cm from 8 to 18 years.

There is a variation in thigh length, as indicated by standard deviation which reflects the dispersion around the mean thigh length varies from a minimum of 1.44 cm at 9 years to maximum of 2.54 cm at 15 years among Garhwali females while for Jaunsari females it ranges from a minimum of 1.59 cm at 8 years to maximum of 2.89 at 13 years. Greater individual variation denoted by high value of standard deviation at particular age during growth which may be due to differences in growth patterns at individual level. The difference between the two groups in mean thigh length was statistically significant at 8 to 13, 16 and 18 years.

The former and later age group difference is obtained to assess the annual increase in thigh length at different age groups from 8 to 18 years. It is observed that the rate of growth among Garhwali females varies from a minimum of -0.24 cm between 16-17 years to a maximum of 2.90 cm between 11-12 years where as among Jaunsari females it varies from a minimum of -0.56 cm between 13-14 years to a maximum of 2.70 cm between 12-13 years which corresponds to the period of adolescent spurt in thigh length as represented through the bar diagram depicting annual increase (Figure 4.1.2.8 b) with minimal decline in Garhwali and Jaunsari females.

4.1.2.9 Foot length

Table 4.1.2.9 depicts the measures of central tendency and dispersion along with annual increase in foot length among Garhwali and Jaunsari Rajput females ranging in
age from 8 to 18 years. It is observed from the table that Garhwali females exhibit an increase in the foot length from 18.75 cm at 8 years to maximum of 22.42 cm at 17 years with slight decline at 15, 16 and at 18 years. While the Jaunsari females exhibit 17.21 cm at 8 years to maximum of 22.43 cm at 18 years with slight decline at 16 years, as demonstrated through the distance curve plotted for foot length (Figure 4.1.2.9 a). Garhwali females exhibit an overall increase of 3.67 cm and Jaunsari females exhibit 5.22 cm from 8 to 18 years. On subjecting the data to test of significance, it is observed that apparent variation occur at 8 to 10, 17 and 18 years.

Variation in foot length, as observed by standard deviation which reflects the dispersion around the mean foot length varies from a minimum 0.79 cm at 16 years to maximum of 1.26 cm at 11 years among Garhwali females. Whereas in case of Jaunsari females standard deviation varies from a minimum 0.50 cm at 9 years to maximum of 1.14 cm at 15 years. High value of standard deviation at particular age during growth denotes greater individual variation. This variation may be due to differences in growth patterns at individual level.

Difference between the preceding and succeeding age groups is obtained to assess the annual increase in foot length at different age groups from 8 to 18 years. It is observed among Garhwali females that the rate of growth varies from a decline of -0.45 cm between 17-18 years to a maximum of 1.17 cm between 9-10 years while among Jaunsari females it also varies from a decline of -0.39 cm between 15-16 years to a maximum of 1.99 cm between 10-11 years, which corresponds to the period of adolescent spurt in foot length as represented through the bar diagram depicting annual increase (Figure 4.1.2.9 b).

4.1.3 Breadths

4.1.3.1 Biacromial breadth

Among Garhwali and Jaunsari Rajput females ranging in age from 8 to 18 years, it can be interpreted from the table (4.1.3.1) that the Garhwali females show an increase in the biacromial breadth from 28.18 cm at 8 years to maximum of 35.15 cm at 17 years with slight decline at 16 and 18 years. On the other hand Jaunsari females
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exhibit 26.44 cm at 8 years and 35.10 cm at 18 years with slight decline at 16 years, as shown in distance curve plotted for biacromial breadth (Figure 4.1.3.1 a). It is evident that the Garhwali and Jaunsari females exhibit an overall increase of 6.87 cm and 8.66 cm respectively from 8 to 18 years of age. The difference between the mean Biacromial breadth of these two population females was statistically significant at 8 to 12, 15, 16 and 17 years.

High value of standard deviation at particular age during growth denotes greater individual variation. This variation may be due to differences in growth patterns at individual level. The variation in biacromial breadth, as observed through standard deviation which reflects the dispersion around the mean biacromial breadth varies from a minimum of 0.95 cm at 18 years to maximum of 2.27 cm at 16 years among Garhwali females while for Jaunsari females it ranges from a minimum of 0.89 cm at 8 years and 9 years to maximum of 2.16 cm at 14 years.

To evaluate the annual increase in biacromial breadth at different age groups from 8 to 18 years, differences between the preceding and succeeding age groups were obtained. It is observed that the rate of growth varies from a minimum of -1.04 cm between 15-16 years to a maximum of 2.24 cm between 11-12 years among Garhwali females while among Jaunsari females it varies from a minimum of -0.47 cm between 15-16 years to a maximum of 2.09 cm between 12-13 years, which corresponds to the period of adolescent spurt in biacromial length as represented through the bar diagram depicting annual increase (Figure 4.1.3.1 b). Jaunsari females shows a negligible decline at 16 whereas Garhwali females results a significant decline of -1.04 cm between 15-16 years which might be due to sudden increase in activity level which may increase the energy demand in relation to energy intake or inadequate nutrition at these ages or cross sectional nature of data.

4.1.3.2 Bicristal breadth

The mean values and other statistical constants along with annual increase in bicristal breadth among Garhwali and Jaunsari Rajput females ranging in age from 8 to 18
years is illustrated in table 4.1.3.4. It is observed from the table that Garhwali females exhibit an increase in the bicristal breadth from 22.78 cm at 9 years to maximum of 27.71 cm at 17 years with slight decline at 16 and 18 years whereas among Jaunsari females it increases from 22.37 cm at 8 years to maximum of 28.12 cm at 17 years with slight decline at 18 years, as shown in distance curve plotted for bicristal breadth (Figure 4.1.3.2 a). It is evident that the Garhwali and Jaunsari females exhibit an overall increase of 4.93 cm and 5.71 cm from 8 to 18 years respectively. Bicristal breadth of these two population group females was statistically significant at 8,10,11 and 12 years.

The Standard deviation which reflects the dispersion around the mean bicristal breadth varies from a minimum of 1.23 cm at 18 years to maximum of 1.93 cm at 16 years expressing the extent of variance in bicristal breadth among Garhwali females. In case of Jaunsari females standard deviation varies from a minimum of 0.91 cm at 8 years to maximum of 1.96 cm at 13 years. High value of standard deviation at particular age during growth denotes greater individual variation, which can be due to differences in growth patterns at individual level.

In bicristal breadth the annual increase is studied in different age groups from 8 to 18 years. It is observed that the rate of growth among Garhwali females varies from a negligible decline of -0.22 cm between 17-18 years to a maximum of 1.31 cm between 11-12 years. Among Jaunsari females it varies from a minimal decline of -0.54 cm between 17-18 years to a maximum of 1.55 cm between 12-13 years, as represented through the bar diagram (Figure 4.1.3.2 b).

4.1.4 Circumferences

4.1.4.1 Mid upper arm circumference

Table 4.1.4.1 illustrates the measures of central tendency and dispersion along with annual increase in mid upper arm circumference among Garhwali and Jaunsari Rajput females ranging in age from 8 to 18 years. It is observed from the table that Garhwali females exhibit an increase in the upper arm circumference from 17.28 cm at 9 years
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to maximum of 21.65 cm at 17 years with slight decline at 9, 15 and 18 years. On the 
other hand Jaunsari females exhibit an increase from 16.39 cm at 8 years to 
maximum of 22.49 cm at 17 years with slight decline at 18 years, as shown in 
distance curve plotted (Figure 4.1.4.1 a). It is evident that the Garhwali females 
exhibit an overall increase of 4.37 cm and Jaunsari females exhibit 6.1 cm from 8 to 
18 years. The difference between the two groups in mean Mid upper arm 
circumference was statistically significant at 8 to 11 and 17 years.

The variation in mid upper arm length, as indicated by standard deviation which 
reflects the dispersion around the mean mid upper arm circumference varies from a 
minimum of 0.94 cm at 8 years to maximum of 2.05 cm at 17 years among Garhwali 
females while for Jaunsari females it varies from a minimum of 0.61 cm at 11 years to 
maximum of 2.06 cm at 18 years. Individual variations which may be due to 
differences in growth patterns at individual level are responsible for higher value of 
standard deviation at particular age during growth.

The annual increase in mid upper arm circumference at different age group is 
evaluated by studying the differences between the preceding and succeeding age 
groups of 8 to 18 years of age. It is observed among Garhwali females that the rate of 
growth varies from a minimum of -0.28 cm between 17-18 years to a maximum of 
1.45 cm between 12-13 years whereas among Jaunsari females rate of growth varies 
from a minimum of -0.84 cm between 17-18 years to a maximum of 1.41 cm between 
11-12 years, which corresponds to the period of adolescent spurt in mid upper arm 
circumference as represented through the bar diagram depicting annual increase 
(Figure-4.1.4.1 b) with negligible Decline in both Garhwali and Jaunsari females.

4.1.4.2 Waist circumference

For Garhwali and Jaunsari Rajput females ranging in age from 8 to 18 years, table 
4.1.4.2 explains the mean values and other statistical constants along with annual 
increase in waist circumference. It is observed from the table that Garhwali females 
exhibit an increase in the waist circumference from 55.83 cm at 8 years to maximum
of 68.38 cm at 17 years with a slight decline at 16 and 18 years whereas among Jaunsari females it increases from 52.50 cm at 8 years to maximum of 68.64 cm at 18 years with slight decline at 14 years, as shown in distance curve plotted (Figure 4.1.4.2 a). It is evident that the Garhwali and Jaunsari females exhibit an overall increase of 12.55 cm and 16.14 cm respectively from 8 to 18 years.

On subjecting the data to test of significance, it is observed that apparent variation occur at 8,9,12,13,17 and 18 years. During growth the high value of standard deviation at particular age denotes greater individual variation which occurs due to differences in growth patterns at individual level. The Standard deviation which reflects the dispersion around the mean waist circumference varies from a minimum of 3.16 cm at 18 years to maximum of 4.82 cm at 14 years among Garhwali females while for Jaunsari females it ranges from a minimum of 1.96 at 8 years to maximum of 4.64 cm at 14 years, expressing the extent of variance in waist circumference.

Difference between the former and later age groups is obtained to assess the annual increase in waist circumference at different age groups from 8 to 18 years. In Garhwali females the rate of growth varies from a minimum of -1.89 cm between 17-18 years to a maximum of 3.66 cm between 11-12 years where as among Jaunsari females rate of growth varies from a minimum of -1.41 cm between 13-14 years to a maximum of 4.01 cm between 10-11 years, which corresponds to the period of adolescent spurt in waist circumference as represented through the bar diagram depicting annual increase (Figure-4.1.4.2 b). Among Garhwali and Jaunsari females a significant decline of -1.89 cm between 17 to 18 years and a decline of -1.41 cm between 13 years and 14 years respectively occurs which might be due to cross sectional nature of data or inadequate nutrition at these ages or sudden increase in the energy demand in relation to energy intake due to increase in activity level.

4.1.4.3 Hip circumference

For Garhwali and Jaunsari Rajput females ranging in age from 8 to 18 years, the measures of central tendency and dispersion along with annual increase in hip circumference is shown in table 4.1.4.3. It can be interpreted from the table that the
Garhwali females exhibit an increase in the hip circumference from 68.32 cm at 8 years to maximum of 85.53 cm at 18 years on the other hand Jaunsari females exhibit 64.15 cm at 8 years and 84.74 cm at 18 years with slight decline at 16 years, as shown in distance curve plotted (Figure- 4.1.4.3 a). It is evident that the Garhwali females exhibit an overall increase of 17.21 cm whereas the Jaunsari females exhibit an increase of 20.50 cm from 8 to 18 years of age.

The variation in hip circumference, as indicated by standard deviation which reflects the dispersion around the mean hip circumference varies from a minimum of 3.73 cm at 8 years to maximum of 6.28 cm at 11 years among Garhwali females while for Jaunsari females it ranges from a minimum of 1.95 cm at 8 years to maximum of 5.46 cm at 14 years. High value of standard deviation at particular age during growth denotes greater individual variation. This variation may be due to differences in growth patterns at individual level. The difference between the two groups in mean hip circumference was statistically significant at 8 to 10,12, 15, 16 and 17 years.

At different age groups from 8 to 18 years, difference between the preceding and succeeding age groups is obtained to assess the annual increase in hip circumference. It is observed that the rate of growth varies from a minimum of 0.10 cm between 15-16 years to a maximum of 5.82 cm between 11-12 years among Garhwali females where as among Jaunsari females it varies from a minimum of -0.63 cm between 15-16 years to a maximum of 4.04 cm between 10-11 years, which corresponds to the period of adolescent spurt in hip circumference as represented through the bar diagram depicting annual increase (Figure 4.1.4.3 b)with negligible decline among Jaunsari females at 16.

4.1.5 Skinfolds

4.1.5.1 Triceps skinfold

Table 4.1.5.1 explains the mean values and other statistical constants along with annual increase in triceps skinfold among Garhwali and Jaunsari Rajput females ranging in age from 8 to 18 years. It is observed from the table that Garhwali females exhibit an increase in the tricep skinfold from 16.29 mm at 8 years to maximum of
20.57 mm at 17 years with slight decline at 11, 13, 16 and 18 years. On the other hand among Jaunsari females it increases from 15.36 mm at 8 years to maximum of 20.67 mm at 18 years with slight decline at 16 years, as shown in distance curve plotted for triceps skinfold (Figure 4.1.5.1 a). It is evident that the Garhwali and Jaunsari females exhibit an overall increase of 4.23 mm and 5.31 mm from 8 to 18 years of age respectively. The difference between the two groups in mean thigh length was statistically significant at 8 to 10, 17 and 18 years.

High value of standard deviation at particular age during growth denotes greater individual variation, which can be due to differences in growth patterns at individual level. The standard deviation which reflects the dispersion around the mean triceps skinfold varies from a minimum of 0.60 mm at 8 years to maximum of 2.19 mm at 15 years among Garhwali females while for Jaunsari females it ranges from a minimum of 0.36 mm at 10 years to maximum of 2.06 mm at 15 years.

It is observed that the rate of growth in Tricep skinfold varies from a minimum of -1.10 mm between 17-18 years to a maximum of 1.36 mm between 9-10 years among Garhwali females whereas among Jaunsari females it varies from a minimum of -0.25 mm between 15-16 years to a maximum of 1.75 mm between 10-11 years, as represented through the bar diagram depicting annual increase (Figure 4.1.5.1 b), both population show minimal decline.

4.1.5.2 Calf skinfold

The mean values and other statistical constants of calf skinfold along with annual increase among Garhwali and Jaunsari Rajput females ranging in age from 8 to 18 years is shown in table 4.1.5.2. It is observed from the table that Garhwali females exhibit an increase in calf skinfold from 15.94 mm at 8 years to maximum of 18.30 mm at 17 years with slight decline at 16 and 18 years. On the other hand Jaunsari females exhibit 14.55 mm at 8 years and 19.40 mm at 18 years with slight decline at 14 and 15 years, as shown in distance curve plotted for calf skinfold (Figure 4.1.5.2a). Garhwali females exhibit an overall increase of 2.36 mm and Jaunsari females exhibit 4.85 mm from 8 to 18 years.
On subjecting the data to test of significance, it is observed that apparent variation occur at 9, 10, 13, 17 and 18 years. There is a variation in calf skinfold as indicated through standard deviation which reflects the dispersion around the mean calf skinfold varies from a minimum of 0.73 mm at 8 years to maximum of 1.82 mm at 15 years among Garhwali females while for Jaunsari females it ranges from a minimum 0.43 mm at 10 years to maximum of 1.81 mm at 15 years. High value of standard deviation at particular age during growth denotes greater individual variation.

To assess the annual increase, differences between the preceding and succeeding age groups were studied in different age groups from 8 to 18 in calf skinfold. It is observed among Garhwali females that the rate of growth varies from a minimum of -0.29 mm between 15-16 years to a maximum of 0.58 mm between 11-12 years whereas among Jaunsari females rate of growth varies from -0.10 mm between 13-14 years to a maximum of 1.62 mm between 12-13 years, as represented through the bar diagram (Figure 4.1.5.2 b). In case of Jaunsari females a negligible decline at 16 and 18 occurs while among Garhwali females a decline occur at 14 years which might be due to inadequate nutrition at these ages or sudden increase in activity level which may increase the energy demand in relation to energy intake or cross sectional nature of data.

4.1.5.3 Sub scapular skinfold

For Garhwali and Jaunsari Rajput females ranging in age from 8 to 18 years, table 4.1.5.3 depicts the measures of central tendency and dispersion along with annual increase in sub scapular skinfold. It is observed from the table that Garhwali females exhibit an increase in the sub scapular skinfold from 12.74 mm at 8 years to maximum of 15.65 mm at 17 years with slight decline at 11 and 18 years. Among Jaunsari females it increases from 12.41 mm at 8 years to maximum of 15.66 mm at 18 years with slight decline at 14, 16 and 17 years, as shown in distance curve plotted for sub scapular skinfold (Figure 4.1.5.3 a). It is evident that the Garhwali females exhibit an overall increase of 2.91 mm and Jaunsari females exhibit 3.25 mm from 8 to 18 years. Sub scapular skinfold is statistically significant at 8 to 13, 17 and 18 years.
Individual variation at greater level is denoted by high value of standard deviation at particular age during growth which may be due to differences in growth patterns at individual level. The variation in sub scapular skinfold, as indicated through standard deviation which reflects the dispersion around the mean sub scapular skinfold varies from a minimum 0.50 mm at 8 years to maximum of 1.21 mm at 16 years among Garhwali females while for Jaunsari females standard deviation ranges from a minimum 0.25 mm at 9 years to maximum of 1.19 mm at 15 years.

Difference between the former and later age groups is obtained to assess the annual increase in sub scapular skinfold at different age groups from 8 to 18 years. It is observed among Garhwali females that the rate of growth varies from a minimum of -0.87 mm between 17-18 years to a maximum of 0.83 mm between 8-9 years whereas among Jaunsari females it varies from a minimum of -0.41 mm between 13-14 years to a maximum of 1.18 mm between 10-11 years, as represented through the bar diagram depicting annual increase (Figure 4.1.5.3 b) with minimal decline in Garhwali and Jaunsari Females.

4.2 Nutritional assessment

4.2.1 Body Mass Index (BMI)

Table 4.2.1 expounds the measures of central tendency and dispersion along with annual increase in body mass index among Garhwali and Jaunsari Rajput females ranging in age from 8 to 18 years. It can be interpret from the table that in Garhwali females the body mass index fluctuate between 16.54 g/m² at 8 years to 21.18 Kg/m² at 16 years, whereas among Jaunsari females it ranges between 15.47 Kg/m² at 8 years to 21.67 Kg/m² at 18 years, as shown in distance curve plotted for body mass index (Figure- 4.2.1 a). It is evident that the Garhwali females exhibit an overall increase of 4.38 Kg/m² and Jaunsari females exhibit 5.20 Kg/m² from 8 to 18 years. The ‘t’ test reveals that Body mass index is significant at 8, 9 and 11 to 15 years.

The variation in body mass index, as observed through standard deviation, which reflects the dispersion around the mean Body Mass Index varies from a minimum of 1.03 Kg/m² at 16 years to maximum of 1.96 Kg/m² at 12 years among Garhwali
females while for Jaunsari females it varies from a minimum 1.13 Kg/m² at 9 years to maximum of 1.84 Kg/m² at 12 years. Individual variations are responsible for higher value of standard deviation at particular age during growth. This variation may be due to differences in growth patterns at individual level.

The annual increase in Body Mass Index at different age group is evaluated by studying the differences between the preceding and succeeding age groups of 8 to 18 years of age. It is observed among Garhwali females that the rate of growth varies from a minimum of 0.10 Kg/m² at between 16-17 years to a maximum of 1.21 Kg/m² between 12-13 years whereas among Jaunsari females rate of growth varies from a minimum of 0.06 Kg/m² between 17-18 years to a maximum of 1.45 Kg/m² between 10-11 years, as represented through the bar diagram depicting annual increase (Figure-4.2.1 b).

4.2.2 Waist hip ratio (WHR)

The measures of central tendency and dispersion along with annual increase in waist hip ratio among Garhwali and Jaunsari Rajput females ranging in age from 8 to 18 years is depicted in table 4.2.2. It is observed from the table that Garhwali females exhibit fluctuation in the waist hip ratio with a minimum of 0.765 at 16 years to a maximum of 0.875 at 17 years. Whereas among Jaunsari females waist hip ratio fluctuates between 0.786 at 14 years to 0.837 cm at 11 years, as shown in distance curve plotted for (Figure- 4.2.2 a). Waist hip ratio is significant at 8-13, 14, 15, 16 and 18.

As indicated by standard deviation, the variation in waist hip ratio reflects the dispersion around the mean waist hip ratio varies from a minimum of 0.029 at 10 years to maximum of 0.051 at 12 years among Garhwali females while for Jaunsari females it ranges from a minimum of 0.018 at 10 years to maximum of 0.264 at 8 years denotes greater individual variation. Greater individual variation may be due to differences in growth patterns at individual level is denoted by high value of standard deviation at particular age during growth.
The annual increase in Waist hip ratio at different age group is evaluated by studying the differences between the preceding and succeeding age groups of 8 to 18 years of age. It is observed among Garhwali females that the rate of growth varies from a minimum of -0.013 between 13-14 years and 14-15 years to a maximum of 0.042 between 16-17 years with minimal decline whereas among Jaunsari females the rate of growth varies from a minimum of 0.040 cm between 13-14 years to a maximum of 0.013 between 8-9 years with a negligible decline, as represented through the bar diagram depicting annual increase (Figure 4.2.2 b).

4.2.3 Percentile Calculation for Body weight, Height, WHR and BMI.

For the study of age changes, it is a usual practice to calculate the 3rd, 10th, 25th, 75th, 90th and 97th percentile, which is calculated by simply by adding and subtracting a multiple of standard deviation to and from the mean as has been done by various researchers to date.

4.2.3.1 Percentile Calculation for Body weight

Percentile Distribution is represented in tables 4.2.3.1.1 and 4.2.3.1.2 for Garhwali and Jaunsari Rajput females for weight. Among Garhwali Rajput females a maximum of 41 (67.21%) subjects fall under the normal range (75th-25th) of percentile at 16 years and minimum of 23 (40.35%) subjects fall under the normal range (75th-25th) of percentile at 10 years, whereas as among Jaunsari Rajput females a maximum of 37 (61.67%) subjects fall under the normal range (75th-25th) of percentile at 13 years and minimum of 24 (37.5%) subjects fall under the normal range (75th-25th) of percentile at 14 years. Among Garhwali Rajput females except in the age groups 14, 16 and 18 years, not a single subject falls beyond 97th percentile category, whereas among Jaunsari Rajput females except in the age groups 8, 9, 10, 14, 16 and 18 years, other age groups don’t have any subject under less than 97th percentile category. In less than 3rd percentile category only age group 8 have 3 subjects among Garhwali Rajput females. Among Jaunsari Rajput females age groups like 9, 11 and 15 have subjects in less than 3rd percentile category.
4.2.3.2 Percentile Calculation for Height

Tables 4.2.3.2.1 and 4.2.3.2.2 represents Percentile Distribution of Garhwali and Jaunsari Rajput females for height. In case of Garhwali Rajput females a maximum of 30 (49.18%) subjects fall under the normal range (75th-25th) of percentile at 16 years and minimum of 19 (32.20%) subjects fall under the normal range (75th-25th) of percentile at 12 years, whereas among Jaunsari Rajput females maximum of 30 (53.57%) subjects fall under the normal range (75th-25th) of percentile at 17 years of age and a minimum of 16 (27.12%) subjects fall under the normal range (75th-25th) at 10 years of age. Among Garhwali Rajput females except in age groups 15, 16 and 18, no subject falls beyond 97th percentile category, whereas in case of Jaunsari Rajput females, except age groups 10 and 17 years, other age groups don’t have individual under less than 97th percentile category. In less than 3rd percentile category 6 age groups 10, 13, 14, 15, 16 and 17 years have subjects among Garhwali Rajput females, whereas in case of Jaunsari Rajput females age groups 10, 13, 14 and 18 years have subjects in less than 3rd percentile category.

4.2.3.3 Percentile Calculation for WHR

For Garhwali and Jaunsari Rajput females the Percentile Distribution for WHR is represented in tables 4.2.3.3.1 and 4.2.3.3.2 Among Garhwali Rajput females a maximum of 39 (60%) subjects fall under the normal percentile range of (75th-25th) at 10 years and a minimum of 26 (43.33%) subjects fall under the normal percentile range (75th-25th) at 13 years, whereas as among Jaunsari Rajput females a maximum of 60 (100%) subjects fall under the normal percentile range of (75th-25th) at 8 years and minimum of 25 (42.37%) subjects fall under the normal percentile range of (75th-25th) at 10 years. In case of Garhwali Rajput females except age group 10 years rest of the age groups have subjects beyond 97th percentile category, whereas among the Jaunsari Rajput females except age groups 8, 10, 12, 14 and 18 years other age groups have individuals under less than 97th percentile category. Among Garhwali (except 8, 13, 14) and Jaunsari Rajput (8, 15, 17) females all age groups belong to less than third percentile category.
4.2.3.4 Percentile Calculation for BMI

Percentile Distribution of Garhwali and Jaunsari Rajput females for BMI is represented in tables 4.2.3.4.1 and 4.2.3.4.2. Among Garhwali Rajput females, maximum of 37 (63.79%) subjects fall under the normal percentile range of (75\textsuperscript{th}-25\textsuperscript{th}) at 8 years and a minimum of 27 (41.54%) subjects fall under the normal percentile range of (75\textsuperscript{th}-25\textsuperscript{th}) at 10 years, whereas among Jaunsari Rajput females a maximum of 38 (61.29%) subjects fall under the normal percentile range of (75\textsuperscript{th}-25\textsuperscript{th}) at 8 years and a minimum of 29 (45.31%) subjects fall under the normal percentile range of (75\textsuperscript{th}-25\textsuperscript{th}) at 12 years of age. In case of Garhwali Rajput females except in age groups 8, 12, and 16 years rest of the age groups have subjects beyond the 97\textsuperscript{th} percentile category, whereas among Jaunsari Rajput females except in age groups 11 and 15 years other age groups have individuals under less than 97\textsuperscript{th} percentile category. Below 3\textsuperscript{rd} percentile category except at 8, 9, 13, 17 and 18 year of age, other age groups have subjects under this category among Garhwali Rajput females. Whereas subjects present in other age groups except 9, 12, 14 and 17 years belong to less than 3\textsuperscript{rd} percentile category in the case of Jaunsari Rajput females.

4.3 Comparison of BMI and WHR with standard values

4.3.1 Comparison of BMI with WHO and NCHS percentile standards.

Body mass index among Garhwali Rajput females of District Dehradun, Uttrakhand is depicted in table 4.3.1.1 and 4.3.1.2. After comparison of body mass index of present study with NCHS and WHO, it is observed that according to WHO criteria (Table 4.3.1.1), among Garhwali Rajput females total 441 (66.41%) are in normal BMI range, 142 (21.38%) are underweight, 9 (1.35%) are below underweight (below 3\textsuperscript{rd} percentile), 60 (9.04%) are overweight and 12 (1.80%) are obese. In case of Jaunsari Rajput females according to WHO it is observed that total 435 (65.41%) females are in normal BMI range, 166 (24.96%) females are in underweight category, 19 (2.85%) females are below 3\textsuperscript{rd} percentile 39 (5.86%) females are in overweight BMI range and (0.90%) females are in obese category.
According to NCHS criteria (Table 4.3.1.2) among Garhwali females 65.81% are normal, 23.19% are underweight, 7.08% are overweight and 2.72% are below 3rd percentile % are obese. Whereas among Jaunsari females 64.73% are normal, 27.63% are underweight, 4.27% are below 3rd percentile, 3.05% are overweight and 0.30% are obese.

4.3.2 Comparison of WHR among both Populations

After analysis of waist hip ratio within different age groups of Garhwali Rajput females (table 4.3.2.1 and 4.3.2.2) it is observed that there is a difference in the number of low, moderate and high risk waist hip ratio cases. Out of total 664 Garhwali Rajput females (Table 4.3.2.1) (8 years to 18 years) 409 (61.60 %) are at low risk (0.80 or below), 202 (30.42 %) are at moderate Risk (0.81-0.85) and 54 (8.13 %) are at High Risk (0.85or above) which results in the highest percentage 61.60% of females are at low risk and lowest percentage 8.13% of females are at high risk. Highest numbers of low risk cases are found in two age groups 15 years and 16 years, which is 54 females and lowest number which is 23 found again in two age groups 8 years and 9 years. Highest numbers of moderate risk cases are found at the age of 10 years (35) and at the same time lowest number of moderate risk cases found at 16 years (07). Whereas highest number of high risk cases (13) found at 8 years and the lowest number of high risk cases found at 18 years (01). It is clear from this analysis that among Garhwali Rajput females low risk cases increase with age in comparison to high risk cases which exhibit decline with increase in age in comparison of high risk which decreases with the age.

Table 4.3.2.2 depicts waist hip ratio among Jaunsari Rajput females of District Dehradun, Uttarakhand. It is observed that among Jaunsari Rajput females out of total of 655 females (8 to 18 years) 237 (36.18 %) are at low risk (0.80 or below), 298 (45.50 %) are at Moderate Risk (0.81-0.85) and 120 (18.32 %) are at High Risk (0.85or above) which results in the highest percentage 45.50 % of females are at moderate risk and lowest percentage 18.32 % of females are at high risk. Highest number of low risk cases found at 14 years of age (47 females) and lowest number (08 females) found in three age groups 10, 11, and 12 years. Highest number of moderate
risk cases found at the age 10 (45 females) and at the same time lowest number of moderate risk cases found at 15 years (08 females). The highest number of high risk cases (20 females) found in 12 years and lowest number of high risk cases found at age 14 (04).

It is clear from the present analysis that in Jaunsari females, first low risk cases decreases than increases and decreases again in comparison of high risk which increases first than decreases with the age.

It may be concluded after comparison of Garhwali and Jaunsari Rajput females that waist hip ratio in Jaunsari females (18.32 %) are more prone towards high risk than Garhwali females (8.13 %) and Garhwali females are more towards low risk (61.60%) than Jaunsari females (36.18%).

**4.4 Regression analysis among all body measurements**

Table 4.4.1 and 4.4.2 present regression equations and correlation values respectively for 8 years old Garhwali and Jaunsari females. The value of correlation varies from minimum 0.315 (Thigh length) and 0.342 (hip circumference) among Garhwali and Jaunsari females respectively whereas maximum 0.792 and 0.931 (Sitting height) respectively among Garhwali and Jaunsari females. It is further observed that 13 and 14 out of 18 measurements among Garhwali and Jaunsari females respectively show high correlation value with height (above 0.5). Whereas the 3 skin folds, Bicristal breadth and Thigh length among Garhwali and four measurements among Jaunsari females shows a moderate correlation (between 0.2 to 0.5) with height among Garhwali females at 8 years of age. In both population not a single body measurement shows low correlation (below 0.2).

Regression equations and correlation values for 9 years old Garhwali and Jaunsari females are presented in table 4.4.3 and 4.4.4 respectively. It is observed that 15 and 12 out of 18 measurements exhibit high correlation value with height (above 0.5) respectively among Garhwali and Jaunsari females. Whereas the 2 skin folds and Thigh length among Garhwali females and four measurements including 2 lengths, 2 skinfold and 1 circumference among Jaunsari females (between 0.2 to 0.5) reveals a
Results

moderate correlation with height at 9 years. The correlation value varies from minimum 0.263 in Thigh length and 0.048 in subscapular skin fold among Garhwali and Jaunsari females respectively to maximum 0.848 and 0.909 in Sitting height among Garhwali and Jaunsari females respectively. Only subscapular skinfold shows low correlation (below 0.2) in case of Jaunsari females.

In tables 4.4.5 and 4.4.6 correlation values and regression equations for 10 years old Garhwali and Jaunsari females are shown. Among Garhwali and Jaunsari females the values of correlation varies from minimum of 0.037 in Thigh length and 0.142 in Hip circumference respectively to a maximum of 0.833 in Garhwali and 0.803 in Jaunsari in sitting height. It is further observed that 10 and 9 measurements out of 18 measurements exhibit high correlation value with height (above 0.5) among Garhwali and Jaunsari Rajput females. In comparison of 7 and 8 measurements among Garhwali and Jaunsari females respectively presents moderate correlation (between 0.2 to 0.5). Whereas Thigh length and Hip circumference shows low correlation (between 0 to 0.2) with height among Garhwali and Jaunsari females at 10 years respectively.

The value of correlation varies from minimum of 0.038 in Thigh length to a maximum of 0.826 in Lower Leg Length among Garhwali females whereas Jaunsari females shows that minimum 0.008 in waist circumference to maximum 0.828 in sitting height correlation values varies at 11 years as represented in tables 4.4.7 for Garhwali and 4.4.8 for Jaunsari Rajput females. It is further observed that 9 among Garhwali and 4 measurements among Jaunsari females exhibit high correlation value with height (above 0.5). Among Garhwali females 1skinfold, 3 circumferences, 1Breadth and 1 length reveals a moderate correlation among Garhwali females in comparison to 10 measurements including 2 skinfold, 2 breadths and 6 lengths among Jaunsari females shows moderate correlation (between 0.2 to 0.5). Calf skin fold, Sub scapular skin fold and Thigh length among Garhwali females and all 3 circumferences and 1 skinfold among Jaunsari females shows low correlation (between 0 to 0.2) with height at 11 year.
In tables 4.4.9 and 4.4.10 regression equations and correlation values for 12 years old Garhwali and Jaunsari females are shown. The correlation value varies from minimum of 0.049 in weight among Garhwali and 0.055 in subscapular among Jaunsari to a maximum of 0.804 in Total lower extremity length and 0.823 in sitting height among Garhwali and Jaunsari Rajput females respectively. It is further observed that 5 and 4 measurements exhibit high correlation value with height (above 0.5) among Garhwali and Jaunsari females respectively. At the same time, 8 and 12 measurements reveal a moderate correlation (between 0.2 to 0.5) among Garhwali and Jaunsari females respectively including lengths, circumference and skinfolds along with breadths in Jaunsari females. Whereas at 12 years, 5 and 2 measurements among Garhwali and Jaunsari females respectively shows low correlation (between 0 to 0.2) with height.

At 13 years for Garhwali and Jaunsari females, regression equations and correlation values were shown in tables 4.4.11 and 4.4.12 respectively. It is observed that 4 measurements in Garhwali and 3 measurements in Jaunsari out of 18 measurements exhibit high correlation value with height (above 0.5). Further observed that 2 skin folds, all three circumferences, 4 lengths and 1 breadth among Garhwali and 2 circumferences, 6 lengths, 1 breadth among Jaunsari females reveals a moderate correlation (between 0.2 to 0.5), whereas in Garhwali and Jaunsari 4 and 6 measurements respectively shows low correlation (between 0 to 0.2) with height at 13 years. The value of correlation varies from minimum of 0.014 in fore arm length and 0.027 in subscapular skinfold among Garhwali and Jaunsari respectively to a maximum 0.583 in body weight and 0.558 in sitting height among Garhwali and Jaunsari respectively.

Regression equations and correlation values for 14 years old Garhwali and Jaunsari females are presented in tables 4.4.13 and 4.4.14. The correlation value varies from minimum of 0.093 in Fore arm length to a maximum of 0.859 in Sitting height among Garhwali females in comparison to Jaunsari females correlation value varies from minimum 0.023 in subscapular skinfold to maximum 0.439 in biacromial breadth. It is further observed that only 3 measurements exhibit high correlation value with height (above 0.5) among Garhwali females while there is no case reported
among Jaunsari females. 11 measurements includes two skin fold among Garhwali and 15 measurements among Jaunsari females reveals a moderate correlation (between 0.2 to 0.5) with height at 14 years. Only 4 body measurements including tricep skinfold in Garhwali and 3 measurements including subscapular skinfold in Jaunsari shows low correlation (below 0.2).

For Garhwali and Jaunsari females, regression equations and correlation values for 15 years old are presented in table 4.4.15 and 4.4.16 respectively. Among Garhwali females the value of correlation varies from minimum 0.032 (Thigh length) to a maximum 0.679 (Sitting height) whereas it varies from 0.011 (mid upper arm circumference) to 0.608 (total lower extremity length) among Jaunsari females. High correlation value with height (above 0.5) among Garhwali and Jaunsari females are represented by 4 and 2 measurements respectively. In comparison, 9 and 10 measurements among Garhwali and Jaunsari females respectively shows a moderate correlation (between 0.2 to 0.5) with height at 15 years. Low correlation (below 0.2) represented through 5 in Garhwali and 6 in Jaunsari body measurements including three skin fold.

At 16 years the regression equations and correlation values is given in Table 4.4.17 and 4.4.18 for Garhwali and Jaunsari females respectively. The value of correlation varies from minimum 0.043 in calf skin fold in Garhwali and 0.002 in fore arm length in Jaunsari to a maximum 0.902 in Sitting height in Garhwali and 0.676 in total lower extremity length in Jaunsari. Among Garhwali and Jaunsari females high correlation value with height (above 0.5) is exhibited by 7 and 2 out of 18 measurements. While 9 measurements includes two skin fold and 11 measurements shows a moderate correlation (between 0.2 to 0.5) with height among Garhwali and Jaunsari females at 16 years respectively. Only two body measurements including fore arm length and calf skin fold among Garhwali and 5 measurements including 1 circumference, 2 lengths and 2 skinfolds among Jaunsari females show low correlation (below 0.2).

Tables 4.4.19 and 4.4.20 represents regression equations and correlation values for 17 years old Garhwali and Jaunsari females. Subscapular skin fold results minimum
correlation value of 0.012 and maximum of 0.831 for body weight among Garhwali females but among Jaunsari it varies from minimum 0.055 for subscapular skinfold and maximum 0.803 for sitting height. High correlation value with height (above 0.5) exhibited by 6 and 3 out of 18 measurements among Garhwali and Jaunsari females respectively, whereas Garhwali and Jaunsari females 7 and 11 measurement reveals a moderate correlation (between 0.2 to 0.5) with height respectively. Low correlation (below 0.2) values exhibited by 5 measurents Garhwali and 4 measurements in Jaunsari including all three skin fold.

Correlation values and regression equations for 18 years old Garhwali and Jaunsari females are represented in table 4.4.21 and 4.4.22 respectively. It is observed that only 4 (sitting height, total lower extremity length, tricep skinfold and lower leg length) and 2 (sitting height and total lower extremity length) out of 18 measurements show high correlation value with height (above 0.5) among Garhwali and Jaunsari females respectively. In comparison 7 measurements shows a moderate correlation (between 0.2 to 0.5) in both populations. Values for low correlation (between 0 to 0.2) with height among Garhwali and Jaunsari females exhibited by 7 and 9 measurements respectively including skinfolds, lengths, breadths and circumferences at 18 years. Mid upper arm circumference results minimum correlation value of 0.031 and maximum of 0.667 for sitting height among Garhwali females but among Jaunsari it varies from minimum 0.006 for cay skinfold and maximum 0.681 for sitting height.