OBSERVATIONS

Anthropometric profile and pulmonary functions of bronchial asthma patients and control subjects have been studied and results obtained through statistical computation have been presented in tabular form for both the sexes in both the groups. Figures based on various observations have been drawn to illustrate the results. The results of the study have been grouped as follows:

I. Anthropometric Measurements
   a) Weight
   b) Linear measurements
   c) Circumferences and chest width
   d) Skinfolds
   e) body mass index
   f) Waist to hip ratio
   g) Body composition

II. Pulmonary Functions
   a) Forced Vital Capacity (FVC)
   b) Forced Expiratory Volume in One Second (FEV1)
   c) FEV1/FVC
   d) Forced Expiratory Flow (FEF) 25%-75%
e) Peak Expiratory Flow Rate (PEFR)

f) Forced Expiratory Volume in Three Seconds (FEV3)

g) FEV3/FVC

h) Lung age

III. Pulmonary functions according to BMI

IV. Pulmonary functions according to waist circumference

V. Pulmonary functions according to waist to hip ratio

VI. Pulmonary functions according to smoking status

VII. Pulmonary functions according to duration of disease

VIII. Pulmonary functions according to severity of disease

I. Anthropometric Measurements

a) Weight

Table 3 and figure 1 present the age changes and comparison of weight among patients and controls from age group 20-29 years to 70+ years. In patient males, an overall trend of decrease in weight with increasing age with some fluctuations has been observed. In control group, the mean weight has increased from 60.61 kg at 20-29 years to 71.27 kg at age group 40-49 years followed by decrease reaching 62.87 kg at 70+ years of age.

In females also, there is a trend of increase in weight with increasing age followed by decrease in both patients and controls. In patients the weight has increased from 52.58 kg at the age group of 20-29 years to 60.91 kg at 40-49 years followed by decrease
reaching the value of 49.22 kg at 70+ years. In control group, the mean weight at 20-29 years is 55.52 kg and has increased to 70.43 kg at age group 50-59 years followed by decrease to 55.20 kg at 70+ years. The distance curves reveal a similar trend of increase and decrease in weight of both patients and controls. It has been observed that patients (both males and females) are lighter in weight than controls in all age groups with statistically significant differences at the age groups of 40-49, 60-69 and 70+ years in males and at age groups of 40-49, 50-59 and 60-69 years in females.

b) Linear measurements

The linear measurements studied include stature, sitting height and subischial length.

➢ Stature

Table 4 and figure 2 illustrate the trend of change and comparison of stature among patients and controls from age group 20-29 to 70+ years. In male patients, the stature is 167.90 cm at age group 20-29 years followed by trend of decrease reaching a level of 161.45 cm at age of 70+ years. In control group, stature at 20-29 years is 168.60 cm followed by a trend of decrease reaching level of 164.68 cm at 70+ years.

In female patient, stature at 20-29 years is 155.39 cm followed by trend of decrease reaching the level of 152.28 at age group 70+ years. In the control group, the maximum mean height in the age group of 20-29 years is 154.49 cm followed by decrease reaching a mean height of 152.55 cm in the age group of 70+ years of age.

The distance curves for stature run approximately parallel to each other indicating a similar trend of decrease in both patients and controls. While comparing the stature of
patients with controls, it has been observed that the differences in the two groups are statistically insignificant (except 30-39 years age group in males) in both males and females.

- **Sitting height**

Table 5 and figure 3 depict the age changes and comparison of sitting height of the bronchial asthma patients and control subjects. In male patients sitting height shows trend of decrease from 85.99 cm at the age group of 20-29 years to 80.84 cm at 70+ years of age. In control males sitting height has decreased from 85.02 cm at age group 20-29 years to 81.12 cm at the age groups of 70+ years.

In female patients also a clear trend of decrease in sitting height from 79.88 cm at 20-29 years to 76.2 cm at 70+ ages has been observed. In controls females sitting height has decreased from 81.18 cm at 20-29 years to 77.58 cm at 70+ years. The distance curves reveal that the trend of decrease is almost similar in both patient and control subjects. While comparing patients and controls it has been observed that differences in sitting height of both the groups are not statistically significant except in the age group of 30-39 years in males.

- **Subischial length**

Table 6 and figure 4 represent mean values and comparison of subischial length among patients and controls. In both patients and controls, the changes in subischial length with age are lesser as compared to sitting height. In patient males, mean subischial length at 20-29 years is 82.39 cm and at 70+ years it has decreased to 81.74 cm. In control
subjects subischial length at 20-29 years is 82.92 cm and at 70+ years it has been found to be 82.91 cm.

In patient and control females, the mean subischial length at 20-29 years is 76.79 cm and 73.63 cm respectively and at 70+ years it is 76.63 cm and 74.99 cm respectively. Distance curves run almost parallel to each other. While comparing patients and controls, it has been observed that differences in the mean values of subischial length are not statistically significant in both males and females in all the age groups.

c) Circumferences and chest width

➢ **Chest circumference**

This measurement was recorded only in males. Table 7 and fig. 5 illustrate the changes in the chest circumference with age in patients and controls. The chest circumference in patient males has increased from 83.18 cm at the age group of 20-29 years to 88.65 cm at the age group of 50-59 years followed by a trend of decrease to 85.94 cm at the age of 70+ years. In control males, the mean chest circumference shows an increase from 84.16 cm at 20-29 years to 91.83 cm at 60-69 years with slight fluctuation and after that it decreases to 81.83 cm at the age 70+ years. Distance curves reveal that chest circumference values are higher in control group except in the age group of 70+ years. Comparison among patients and controls shows that there are no statistically significant differences in chest circumference of patients and controls.

➢ **Waist circumference**

In patient males, waist circumference has a trend of increase from 76.39 cm at the
age group of 20-29 years to 87.49 cm at the age group of 50-59 years; afterwards there is trend of decrease to 79.39 cm at age 70+ years (Table 8 and Fig. 6). In control males also mean waist circumference values show a trend of increase from 75.49 cm at the age of 20-29 years to 88.64 cm at the age of 60-69 years and at the age of 70+ years it decreased to 78.25 cm.

In patient females waist circumference has increased from 71.82 cm at 20-29 years of age to 85.94 cm at the age group of 40-49 years followed by a trend of decrease with the waist circumference value of 77.60 cm at the age of 70+ years. In control females, waist circumference increases from 71.55 cm at the age group of 20-29 years to 87.69 cm at the age group of 50-59 years and thereafter, there is a decrease in waist circumference to 74.55 cm at the age of 70+ years. Distance curves also show that waist circumference values in patients and controls are quite close to each other with control group subjects having slightly higher values of waist circumference in most of the age groups. Comparison of waist circumference among patient and control groups shows that the differences found are statistically not significant.

- **Hip circumference**

Table 9 and figure 7 show mean values and comparison of hip circumference of patients and control subjects. In patient males, hip circumference has shown a trend of increase from 87.15 cm at the age group of 20-29 years to 92.21 cm at the age of 50-59 years and thereafter there is a trend of decrease in hip circumference and it has decreased to 88.22 cm at the age of 70+ years. In control males also, there is a trend of increase of
hip circumference from 88.19 cm at 20-29 age years to 93.33 cm at age of 60-69 years with slight fluctuation and again it decreased to 83.59 at the age of 70+ years.

In patient females hip circumference has increased from 83.28 cm at the age group of 20-29 years to 96.44 cm at 40-49 years followed by a trend of decrease to 87.5 cm at the age 70+ years. In the control females also, trend of increase in hip circumference has been observed. It increased from 87.29 cm at the age group of 20-29 years to 100.13 cm at 40-49 years and thereafter it decreased to 89.30 cm at the age of 70+ years. Distance curves also show initially a trend of increase with age followed by decrease in both patients and controls.

On comparison, it has been observed that the hip circumference is slightly bigger in the control males except in the age groups of 50-59 years and 70+ years, though the differences found are statistically not significant. In females also hip circumference is bigger in the control females but the differences found are not statistically significant.

**Upper arm circumference**

Table 10 and figure 8 show the mean values of upper arm circumference in the age range of 20-70+ years in both patient and control subjects. In patient males, there is a trend of decrease in upper arm circumference from 25.52 cm at the age of 20-29 years to 22.08 cm at the age of 70+ years. But in control males, there is a trend of increase of upper arm circumference from 25.15 cm at 20-29 years of age to 27.91 cm at the age of 40-49 years and after wards, there is a trend of decrease of upper arm circumference to 24.56 cm at the age of 70+ years.
In patient females, there is a trend of increase of upper arm circumference from 24.03 cm at 20-29 years of age to 27.93 cm at the age of 40-49 years and thereafter there is a decrease in upper arm circumference to 25.28 cm at the age of 70+ years. In control females mean upper arm circumference increased from 24.27 cm at the age group of 20-29 years to 29.81 cm at the age group of 50-59 years followed by a trend of decrease to 25.12 cm at the age 70+ years. Distance curves reveal similar trend of increase and decrease in both patients and controls. While comparing it has been observed that the patients have lower values of upper arm circumference with statistically significant differences in the age groups of 40-49 years, 50-59 years and at age of 70+ years in males and 30-39 years and 50-59 years in females.

- Chest width

Table 11 and figure 9 present the mean values and comparison of chest width of patients and controls. In patient males, mean chest width increased from a mean value of 29.60 cm at the age group of 20-29 years to 29.75 cm at 50-59 years followed by decrease to 28.37 cm at the age of 70+ years. In control males also there is trend of increase in chest width from 30.30 cm at the age group of 20-29 years to 32.93 cm at the age group of 40-49 years, followed by decrease to 29.54 cm at 70+ years of age.

In patient females, there is a trend of increase in chest width from 27.54 cm at the age group of 20-29 years to 28.37 cm at the age group of 50-59 years. After this age group, there is continuous decrease in chest width to 25.11 cm at the age group 70+ years.
In control females, chest width continued to increase up to the age group of 50-59 years and afterwards there is decrease in chest width. Distance curves run almost parallel to each other with similar trend of increase and decrease in chest width with increase in age.

While comparing it has been observed that patients have lower values of chest width than controls in all the age groups and the differences are statistically insignificant except in the age groups of 40-49 years in males and 50-59 years and 60-69 years in females.

d) Skin folds

- **Biceps**

Table 12 and Figure 10 summarize the mean values of biceps from age group 20-29 years to 70+ years in both patient and control groups. In patient males, there is increase in mean values of biceps skin fold from 9.80 mm at 20-29 years to 10.35 mm at 30-39 years followed by a trend of decrease to 6.67 mm at 70+ years of age. In control males, mean values of biceps skinfold have shown a trend of increase from 6.87 mm at 20-29 years to 11.91 mm at 40-49 years and then it decreased to 9.87 mm 70+ years of age with fluctuation in the age group of 60-69 years.

In patient females, biceps skinfold value increased from 14.19 mm at the age group of 20-29 years to 14.67 mm at the age group of 40-49 years. Trend of decrease started from 50-59 years of age and decline continued up to 70+ years of age. In control females also, there is trend of increase in mean values of biceps skin fold from the age group of
20-29 to 50-59 years of age and thereafter there is a trend of decrease up to 70+ years of age. While comparing patients and controls, it has been observed that biceps skin fold values are lower in patients after 30-39 years in males and 20-29 years in females with statistically significant differences except in the age groups of 20-29 and 50-59 years in males. In females the differences are statistically significant at 20-29 and 50-59 years. Distance curves reveal that increase in biceps skinfold with increasing age is less in patients as compared to controls. Initial increase is followed by decrease in both patients and controls.

➢ Triceps

Table 13 and figure 11 present the mean values and comparison of triceps skin fold in patients and controls. In patients males, mean values of triceps skinfold show a trend of continuous decrease from 15mm at 20-29 years to 10.31mm at the age of 70+ years. In control males, the mean values of triceps skin fold initially increase from 14.74 mm at the age group of 20-29 years to 19.12 mm at the age group of 40-49 years followed by a decrease to 13.80 mm at the age group of 70+ years.

In both patient and control females, the mean values of triceps skin fold increased from the age group of 20-29 years to the age group of 40-49 years and from the age of 50 years onwards the trend of decrease in size of triceps skinfold has been observed which continued up to the age of 70+ years. Distance curves reveal that controls have higher values of triceps skinfold in all the age groups except 20-29 years in males. The comparison of patients and controls shows that the differences are statistically significant.
in the age group of 40-49 years, 50-59 years, 60-69 years and 70+ years of age in males and all the age groups in females except 20-29 years.

- **Subscapular**

Table 14 and figure 12 show the age changes and comparison of subscapular skinfold in patients and controls from age group 20-29 years to 70+ years. In patient males, the mean values of skinfold have increased from age group of 20-29 years to the age group of 50-59 years with slight fluctuation and afterward the mean value decreased to 14.83 mm at the age of 70+ years. In control males, initially there is a clear trend of increase from the age group of 20-29 years to 40-49 years. It increased from 16.13 mm at 20-29 years to 22.85 mm followed by a trend of decrease to 19.00 mm at the age of 70+ years.

In both patient and control females, there is initial trend of increase in the values of subscapular skinfold from the age group of 20-29 years to 40-49 years followed by a trend of decrease till the age of 70+ years.

Distance curves also reveal that gain in thickness of subscapular skinfold with increasing age is less in patients as compared to controls. While comparing the patients and controls it has been observed that patient males have lower values of subscapular skinfold in all age groups except 20-29 years of age with statistically significant differences at 40-49 and 50-59 years of age. Like males, patient females have lower values of subscapular skinfold as compared to control females in all the age groups with statistically significant differences at the age groups of 30-39, 50-59 and 60-69 years.
Suprailiac

Age changes and comparison of suprailiac skin fold in patient and control have been presented in Table 15 and fig 13. In patient males, the mean values of suprailiac skinfold show a trend of continuous increase from 10.8 mm at the age group of 20-29 years to 12.78 mm at the age group of 40-49 years followed by a trend of decrease which continues up to the age of 70+ years. In control males also there is a trend of increase in the mean values of suprailiac skin fold from 10.58 mm at the age group of 20-29 years to 16.27 mm at the age group of 40-49 years followed by a trend of decrease up to 70+ years with slight fluctuations.

Patient females also show a trend of increase in the values of suprailiac skin fold from 14.32 mm at the age group of 20-29 years to 19.27 mm at the age group of 40-49 years followed by a trend of continuous decrease up to age of 70+ years.

Control females also present with same trend of increase in the size of suprailiac skin fold till the age group of 50-59 years and thereafter there is a trend of decrease in the value of suprailiac skin fold.

Distance curves run almost parallel with curve for patient group running at lower level depicting lower values of suprailiac skinfold for patients. While comparing patients and controls, it has been observed that the differences in the mean values of suprailiac skinfolds are statistically significant in the age groups of 60-69 years and 70+ years in males and 30-39 years, 50-59 years and 60-69 years.
e) Body Mass Index

Table 16 and figure 14 show the mean values of BMI from age group of 20-29 years to 70+ years of age in both patients and controls. In patient males, there is a trend of increase of BMI from a mean value of 21.27 kg/m² at 20-29 years to 22.78 kg/m² at age group 30-39 years followed by a trend of decrease with BMI reaching 19.47 kg/m² at the age group of 70+ years.

In control group, the BMI has increased from a mean value of 21.48 kg/m² at 20-29 years to 25.92 kg/m² at 40-49 years and then there is a decrease reaching a value of 23.37 kg/m² at 70+ years of age.

In female patients, there is a trend of increase in BMI from age group of 20-29 years (21.81 kg/m²) to 40-49 years (26.08 kg/m²) and afterwards there is a trend of decrease in BMI up to 70+ years of age reaching a value of 21.39 kg/m². In control subjects, there is a trend of increase in BMI from 21.95 kg/m² at 20-29 years age group to 29.47 kg/m² at 50-59 years age group. Thereafter there is a trend of decrease in BMI reaching a level of 23.73 kg/m² at 70+ years of age.

Distance curves reveal lesser values of BMI in patients. Comparison of patients and controls shows that in both males and females, the difference in BMI of patients and controls is statistically significant in the age groups of 40-49 years, 60-69 years and 70+ years in males and 40-49, 50-59 and 60-69 years in females with patients having lower values of BMI in all the age groups.
f) Waist to hip ratio

Table 17 and figure 15 present the waist to hip ratio of patient and control subjects in the age range of 20-70+ years. In patient males, there is a trend of increase of waist to hip ratio from 0.87 at 20-29 years to 0.93 at the age group of 50-59 years and afterwards there is a trend of decrease to 0.89 at the age of 70+ years. In control males also first there is a trend of increase of waist to hip ratio from 0.85 to 0.94 till the age of 60-69 years and then there is a decrease of waist to hip ratio to 0.93 at the age of 70+ years.

In patient females, waist to hip ratio shows a trend of increase from 0.82 at the age group of 20-29 years to 0.90 at the age group of 50-59 years and then it decrease to 0.88 at the age of 70+ years. In the control females also waist to hip ratio increases from 0.81 at the age group of 20-29 years to 0.87 at the age of 50-59 years and then there is trend of decrease to 0.85 at the age group of 60-69 years. There is a slight increase at the age of 70+ years.

Distance curves reveal a similar pattern of waist to hip ratio in patients and controls. On comparing patients and controls, it has been observed that the waist hip ratio in male patients is lesser after 30-39 years whereas in female patients it is more in all the age groups. The differences are statistically insignificant in all the age groups except 60-69 years in males.

g) Body composition

Absolute body fat

Table 18 and fig 16 present the age changes and comparison of body fat in
patients and controls. In patient males, total body fat has increased from 12.23 kg at the age group 20-29 years to 15.45 kg at the age group of 50-59 years followed by a decrease in body fat which continues up to the age of 70+ years reaching 11.24 kg. In control males body fat has increased up to 60-69 years and it decreases at the age 70+ years.

In patient females the total body fat has increased from 15.70 kg in the age group of 20-29 years to 21.73 kg at the age group of 40-49 years and then it shows trend of decrease till 60-69 years of age group. In control females, body fat has increased from 15.87 kg at the age of 20-29 years to 27.98 kg at the age group of 50-59 years and after that there is a sharp decrease in body fat which continues up to the age of 70+ years.

Distance curves reveal that patients and controls have similar trend of increase and decrease in amount of absolute body fat with patients having lower values of total body fat in all the age groups except 20-29 years in males and 70+ years in females. While comparing, it has been observed that the differences have reached a level of significance in the age groups of 60-69 years and 70+ years in males and 30-39, 40-49, 50-59 and 60-69 years in females.

**Percent body fat**

The mean values and comparison of percentage body fat are given in Table 19 and figure 17. In patient males the body fat percentage increased from 17.78 kg at the age group of 20-29 years to 24.09 kg at 40-49 years followed by a trend of decrease reaching a value of 21.17 kg at 70+ years. In control males percent body fat has increased till the
age group of 60-69 years with slight decrease at the age of 50-59 years and again followed by decrease in the age group of 70+ years.

In patient females, there is trend of increase in body fat percentage from 29.02 kg at 20-29 years to 35.44 kg at the age group of 50-59 years followed by a trend of decrease till 70+ years of age. In control females also body fat percentage has increased from 28.84 kg at the age group of 20-29 years of age to 39.16 kg at 50-59 years of age followed by decrease to 34.97 kg at 70+ years.

Distance curves reveal that there is similar trend of increase and decrease in percent body fat with increasing age in both patients and controls. While comparing patients and controls it has been observed that patients have lesser value of percent body fat with statistically significant differences in the age groups of 40-49, 60-69 and 70+ years in males and 30-39, 50-59 and 60-69 years in females.

**Absolute lean body mass**

Table 20 and figure 18 depict age changes and comparison of mean values of total lean body mass in different age groups among patients and controls. In patient and control males, total lean body mass have decreased with increasing age with intermittent fluctuations.

In patient females, total lean body mass initially increased with increase in age up to 40-49 years of age and thereafter it has shown a trend of decrease. In control females a clear trend of decrease with intermittent fluctuations has been observed.
Distance curves reveal a similar trend of decrease in lean body mass with increasing age in both patients and controls. While comparing patients and controls it has been observed that patients have lower values of lean body mass in all the age groups with statistically significant differences in the age groups of 40-49 and 60-69 years in males and in all the age groups in females.

**Percent lean body mass**

As it is evident from table 21 and figure 19 that there is decrease in percentage lean body mass with increasing age in both patient and control subjects. In patient males with increasing age there is trend of decrease in percent lean body mass from 82.22 in the age group of 20-29 years to 75.26 in the age group of 50-59 years. In control males also an overall trend of decrease in percent lean body mass has been observed with increasing age. Patients have been found to have higher values of percent lean body mass.

In patient females, percent lean body mass continued to decrease from the age group of 20-29 years to 50-59 years. In the age groups of 60-69 years and 70+ years, there is slight increase in percent lean body mass. In control females also decrease in percent lean body mass is evident. Percent lean body mass decreased from 64.6 in the age group of 20-29 years to 57.31 in the age group of 50-59 years. Percent lean body mass increased slightly in the age groups of 60-69 years and 70+ years.

Distance curves reveal that patients have higher values of percent lean body mass with the trend of decline in both patients and controls. Comparison of patient and control males shows that differences in the percent lean body mass were statistically insignificant.
except in the age groups of 40-49 years, 60-69 years and 70+ years of age. Differences in percent lean body mass values in patient and control females are statistically significant in the age groups of 20-29 years, 30-39 years, 50-59 years and 60-69 years.

II. Pulmonary Functions Measurements

a) Forced vital capacity (FVC)

Table 22 and figure 20 depict age changes and comparison of forced vital capacity among patient and control from age group 20-29 years to 70+ years. In both patients and controls, there is a clear trend of decrease in forced vital capacity with increasing age. A total decrease in FVC from age group 20-29 years up to 70+ years is more in patients i.e. 1.46 L and 0.86 L in males and females respectively and in controls the total decrease in FVC has been found to be 0.92 L and 0.70 L in males and females respectively.

Distance curves run almost parallel to each other with trend of decline continuing with increasing age. While comparing patients and controls, it has been observed that mean values of forced vital capacity in both patient males and females are less and the differences in the mean values are statistically significant in all the age groups except 20-29 years in males and 30-39 years in females.

b) Forced Expiratory Volume in one second (FEV1)

Table 23 and figure 21 present the age changes and comparison of FEV1 among patients and controls. In both patients and controls, clear trend of decrease in FEV1 with increasing age is apparent. The total decrease in FEV1 from age group 20-29 years up to
70+ years is more (1.40L) in male patients as compared to controls (0.86L). In female patients the total decrease is lesser (0.61L) as compared to controls (0.85L).

Distance curves run parallel depicting trend of decline with increasing age for both patients and controls. While comparing patients and controls, it has been observed that patients have lower values of FEV1 as compared to controls and difference in the mean values of FEV1 are statistically significant in all the age groups except 20-29 years in males and 30-39 years in females.

c) Ratio of Forced expiratory volume in one second to forced vital capacity (FEV1/FVC)

Table 24 and figure 22 represent the changes in the mean values of FEV1/FVC among patients and controls. In both patients and controls mean values of ratio of forced expiratory volume in one second to forced vital capacity have decreased with increasing age. Distance curves though run parallel but are widely separated. While comparing patients and controls in all the age groups, patients have been found to have lower values of FEV1/FVC in all the age groups and the differences are statistically significant in all the age groups except 20-29 years in males and 60-69 years in females.

d) Forced expiratory flow (FEF) 25-75%

Table 25 figure 23 present mean values of FEF 25-75 % among patients and controls classified in different age groups. In both patients and controls, FEF 25-75% has shown trend of decrease with increasing age. In patient males, it has decreased from 2.51L/s at 20-29 years age group to 0.53 L/s at 70+ years of age. In control males it has decreased from 2.76 L/s at 20-29 years of age group to 1.75 L/s at 70+ years of age. In
patient females, it has decreased from 2.37 L/s at 20-29 years of age groups to 0.59 L/s at 70+ years and in control females FEF 25-75% has decreased from 2.39 L/s at 20-29 years of age group to 1.22 L/s at 70+ years of age. Distance curves reveal that patients have greater decline in FEF25-75% as compared to controls. While comparing patients and controls, it has been observed that differences in the mean values of FEF 25-75 % are statistically significant in age groups of 30-39, 50-59 and 70+ years in males and from age group 40-49 to 70+ years in females.

e) Peak expiratory flow rate (PEFR)

Table 26 and figure 24 depict age changes and comparison of PEFR among patients and controls. In both patient and control males, a trend of decrease has been observed with increasing age. In patient males, it has decreased from 4.59 L/s at 20-29 years of age to 1.79 L/s at 70+ years of age. In control males, PEFR decreased from 5.07 L/s at 20-29 years of age group to 3.97 L/s at 70+ years of age. In patient’s females, PEFR has decreased from 2.47 L/s at 20-29 years age group to 1.37 L/s at 70+ years of age. In control females, PEFR decreased from 5.45 L/s at 20-29 years of age group to 2.60 L/s at 70+ years of age.

Distance curves reveal greater decline in PEFR in patients as compared to controls. While comparing patients and controls it has been observed that the differences in the mean values of PEFR have been found to be statistically significant in all the age groups except 20-29 years and 70+ years in males and 20-29 years in females.
f) Forced expiratory volume in three seconds (FEV3)

Table 27 and figure 25 present age changes and comparison of FEV3 among patients and controls in the age range of 20 to 70+ years. In patients males, mean values decreased from 3.00 L at 20-29 years age group to 1.54 L at 70+ years of age. In control males, trend of decrease has been observed and FEV3 decreased from 3.41 L at 20-29 years age group to 2.46 L at 70+ years of age. In patient females, FEV3 has decreased from 2.03 L at 20-29 years age group to 1.20 L at 70+ years of age. In control females, FEV3 decreased from 2.66 L at 20–29 years age group to 1.87L at 70+ years of age.

Distance curves run almost parallel to each other and at the same time showing decline in FEV3 in both patients and controls. While comparing patients and controls, it has been observed that in both patient males and females, values of FEV3 are lower than controls in all the age groups with statistically significant differences except 20-29 years in males.

g) Ratio of forced expiratory volume in three seconds to forced vital capacity (FEV3/FVC)

Table 28 and figure 26 depict changes in the mean values of FEV3/FVC among patients and controls from the age groups of 20-29 years to 70+ years. In patient males, values of FEV3/FVC have decreased from 89.86 at 20-29 years to 79.56 at 70+ years. In control males, values of FEV3/FVC decreased from 94.76 at 20-29 years of age to 92.44 at 70+ years of age. In patient females also, trend of decrease has been observed and the ratio decreased from 89.48 at 20-29 years of age to 85.08 at 70+ years of age. In control
males, FEV3/FVC decreased from 98.91 at 20-29 years of age to 93.61 at 70+ years of age.

Distance curves run parallel to each other with patients showing more decline in FEV3/FVC ratio. Comparing patients and controls, it has been observed that values of FEV3/FVC are lower in patients with statistically significant differences in all the age groups except 20-29 years in males.

h) Lung age

Table 29 and figure 27 present age changes and comparison of lung age among patients and controls. In patients males, the lung age increased with increasing age. It increased from 28.80 years at 20-29 years age group to 106.17 years at 70+ years of age. In control males also, it increased with increasing age. It increases from 26.71 years at 20-29 years to 65.87 years at 70+ years of age. In patient females also, trend of increase in lung age is apparent. It increased from 31.22 years at 20-29 years age group to 98.88 years at 70+ years of age. In control females, it increased from 21.83 years at age group of 20-29 years to 72.26 years at 70+ years of age.

Distance curves show an upward trend with increasing age with patient’s lung age curve running higher than controls implying that patient’s lungs are ageing faster than controls. While comparing patients and controls, it has been observed that patients have higher values of lung age in all the age groups in both males and females with statistically significant differences in all the age groups except 20-29 years in males.
**III. Pulmonary functions according to BMI**

Table 30 presents the frequency distribution of asthma patients and control subjects according to body mass index. In both male and female patients, majority of the subjects i.e. 49.7% males and 36.9% females have normal BMI (18.5-24.9) followed by lower BMI (31.48% males and 26.74% females) then overweight category (12.50% males and 21.93% females) and lastly the obese category (6.94% males and 14.44% females). In control group also, majority of the subjects (53.80% males and 38.10% females) fall in the normal BMI category followed by overweight (29.11% males and 29.10% females), obese (8.23% males 27.51% females) and then lastly the lower BMI category (8.86% males and 5.29% females). Observations related to pulmonary functions parameters according to BMI are given below:

a) **Forced vital capacity (FVC)**

Table 31 and figure 28 present mean values of FVC according to body mass index among patients and controls. In patient males, FVC has increased with increase in BMI. It has increased from 2.26 L at BMI < 18.5 (underweight) to 2.96 L at BMI value ≥ 30 (obese). There has been consistent increase in FVC among male asthma patients. In control males, FVC has increased with increase in BMI from 3.14L among underweight (BMI < 18.5) to 3.22 L among overweight (BMI - 25.0-29.9). At BMI level of ≥30 (obese) slight decrease in forced vital capacity has been observed. While comparing effect of BMI on FVC, it has been observed that FVC increases significantly with increase in BMI in patients males where as the difference in the mean values of FVC in different categories
of BMI has not been found to be statistically significant. In patient females, FVC has shown a trend of increase from 1.77L at BMI <18.5 to 1.94L at BMI ≥30. In control females, FVC has increased with increasing BMI till 25.0-25.9 i.e. it increased from 2.08 L to 2.38 L. But with further increase in BMI i.e. at ≥30, it decreased to 2.04 L. The mean values of FVC have been found to be significantly different among different categories of BMI in control females.

b) Forced expiratory volume in one second (FEV1)

Table 32 and figure 29 present changes in FEV1 according to body mass index among patients and controls. Like forced vital capacity, FEV1 has also shown a trend of increase with increase in BMI in patients but in control subjects in the obese category, FEV1 has slightly decreased.

In patient males, it increased from 1.08 L at BMI <18.5 to 1.93 L at BMI ≥30. In control males, no significant variation in FEV1 has been observed with increase in BMI. The mean value of FEV1 at BMI <18.5 is 2.47 L, it decreased to 2.29L at BMI ≥30. In patient females, FEV1 showed an increase in the category of normal BMI but it decreases again in overweight and obese category. In control females, FEV1 increased consistently from 1.51 L at BMI <18.5 to 1.84 L at BMI 25-29.9. Further increase in BMI i.e. ≥30 (obese) control females resulted in decrease in FEV1. The differences in the mean values of FEV1 in different categories of BMI have been found to be statistically significant in control females.
c) Ratio of forced expiratory volume in one second to forced vital capacity (FEV1/FVC)

Changes in the mean values FEV1/FVC with increase in BMI among patient and controls have been given in Table 33 and Figure 30. In patient males, FEV1/FVC increased significantly with increase in BMI. It increased from 49.50 at BMI <18.5 to 69.05 at BMI ≥30. In control males, a decrease in FEV1/FVC has been observed. In both patient and control females, increase in FEV1/FVC has been observed with increase in BMI but the differences in the mean values of FEV1/FVC in different categories of BMI have not been found to be statistically significant.

d) Forced expiratory flow (FEF) 25-75%

Table 34 and figure 31 present changes in FEF 25-75% according to BMI among patients and controls. An overall trend of increase in FEF25-75% with increasing BMI has been observed in both patients and controls except in control males but the differences in the mean values in different categories of BMI have not been found to be statistically significant.

e) Peak expiratory flow rate (PEFR)

Table 35 and figure 32 depict changes in PEFR among patients and controls in different categories of BMI. In patient males, PEFR has increased significantly from 1.95 L/s at BMI <18.5 to 4.24 L/s at BMI ≥30. In control males also it has increased with increase in BMI. But increase is not statistically significant. In patient females, PEFR has increased from 1.56 L/s at BMI <18.5 to 2.10 L/s at BMI ≥30 and the differences in the mean values of PEFR in different categories of BMI are not statistically significant. In
control females also, trend of increase in PEFR has been observed with increase in BMI but the mean values did not differ significantly in different categories of BMI.

f) Forced expiratory volume in three seconds (FEV3)

Table 36 and Figure 33 present changes in FEV3 according to BMI among bronchial asthma patient and control groups. FEV3 increased with increase in BMI in patient males. It increased from 1.68 L at BMI <18.5 to 2.70 L at BMI ≥30. In control males, it has decreased slightly but decrease is not statistically significant. In patient females, it increased from 1.41 L at BMI <18.5 to 1.65 L at BMI ≥30. In control females, it increased from 1.90 L at BMI <18.5 to 2.26 L at BMI 25-29.9, with further increase in BMI i.e. ≥30, FEV3 decreased to 1.92 L. The mean values of FEV3 differed significantly in different categories of BMI in patients (males and females) and control females.

g) Ratio of forced expiratory volume in three seconds to forced vital capacity (FEV3/FVC)

The effect of increase in BMI on FEV3/FVC among patients and controls has been shown in table 37 and figure 34. In patient males, FEV3/FVC increased from 75.23 at BMI <18.5 to 90.77 at BMI ≥30. In control males, it decreased from 97.65 at BMI <18.5 to 92.22 at BMI ≥30. In patient females, increase in FEV3/FVC has been observed with increase in BMI. FEV3/FVC increased from 81.87 at BMI <18.5 to 88.65 at BMI ≥30. In control females also there is increase in FEV3/FVC from 90.63 at BMI <18.5 to 95.47 at BMI ≥30. The differences in the mean values of FEV3/FVC in different categories of
BMI have been found to be statistically significant in patients (males and females) and control males.

h) Lung age

Table 38 and figure 35 present mean values of lung age according to body mass index. Lung age has decreased with increase in BMI among patient males showing positive effect on lung health. In control males also, lung age decreased with increase in BMI up to 25.0 -29.9. With further increase in BMI i.e. ≥30 (obese), lung age increases and that shows deleterious effect on lung health. In patient females lung age has decreased from 69.54 years at BMI <18.5 to 59.56 years at BMI ≥30. In control females also, lung age decreased with increase in BMI. Lung age has been found to differ significantly in different categories of BMI in patient males and control females.

IV. Pulmonary functions according to waist circumference

Table 39 gives the frequency distribution of bronchial asthma patients and control subjects according to waist circumference as per WHO Asia Pacific Prospective Guidelines, (2000) according to which waist circumference > 90 cm in males and > 80 cm in females has been defined as abdominal obesity. The effect of waist circumference on various pulmonary function variables has been described. Table 40 gives comparison of mean values of pulmonary functions of bronchial asthma patients according to waist circumference. The mean values of pulmonary functions parameters in patient males having waist circumference > 90 cm were found to be significantly higher than patient males having waist circumference ≤ 90 cm except FEF 25- 75% and lung age. This shows
that higher waist circumference has a protective effect on pulmonary functions of patient males. In patient females the mean values of all the pulmonary functions parameters (except FVC and lung age) have been found to be higher in the group with waist circumference > 80cm. Lower lung age signifies better lung health in both male and female patients. The differences in the mean values have not been found to be statistically significant for any of the pulmonary function parameters except PEFR and FEV3/FVC.

The control group has shown the reverse picture i.e. male subjects with waist circumference ≤ 90 cm had slightly higher values of pulmonary functions as compared to subjects with waist circumference >90 cm, although differences in the mean values have not been found to be statistically significant except lung age. In females also, subjects with waist circumference ≤ 80 cm have been found to have higher values of pulmonary functions (except lung age) than subjects with >80 cm and the differences have been found to be statistically significant for FVC, FEV1, FEV3 and lung age (Table 41).

V. Pulmonary functions according to waist to hip ratio

Frequency distribution of subjects according to waist to hip ratio as per WHO Asia Pacific prospective guidelines (2000) is given in table 42.

Table 43 gives mean values of pulmonary functions according to waist to hip ratio (WHR) among bronchial asthma patients. Male patients with WHR >0.9 have higher values of all pulmonary functions parameters except FEF25-75% and lung age but the difference in mean values has not reached the level of significance. Whereas in females
with waist to hip ratio \( \leq 0.8 \) have been found to have higher values of all pulmonary functions parameters except FEV1/FVC, PEFR, FEV3/FVC and lung age with differences reaching level of statistical significance for FEV1/ FVC and FEV3/ FVC.

In controls like waist circumference the waist to hip ratio also has shown reverse picture. Male subjects with waist to hip ratio \( \leq 0.9 \) have higher values of pulmonary functions parameters but the differences in the mean values have not reached the level of statistical significance except for FEV1, FEV3 and lung age.

Females also with lower values of waist hip ratio have been found to have higher values of all the pulmonary functions parameters except lung age and the differences in the mean values of pulmonary function parameters have reached level of statistical significance for FVC, FEV1, FEV3 and lung age.

VI. **Pulmonary functions according to smoking status**

Pulmonary functions according to smoking status have been assessed among males only because there were very few female smokers in both patient and control groups. Table 45 and fig.36-43 present mean values of pulmonary function parameters in patient and control males according to their smoking status. In patient males, mean values of all the pulmonary functions have been found to be lower in smokers as compared to nonsmokers and the differences in the mean values are statistically significant for all the pulmonary function parameters.

In control subjects also, smokers have lower values of all the pulmonary function
parameters but the differences in the mean values are not statistically significant for any of the pulmonary function parameters.

It clearly shows highly deleterious effect of smoking on pulmonary function parameters particularly in bronchial asthma patients.

**VII. Duration of asthma and pulmonary functions**

Table 46 presents frequency distribution of bronchial asthma patients according to duration of disease. Table 47 and 48 (fig 44-51) depict mean values of various pulmonary function variables according to duration of disease in male and female bronchial asthma patients respectively.

a) **Forced vital capacity (FVC)**

In patient males, mean values of FVC show a trend of decrease with increasing duration of disease from 2.53L at less than one year duration to 2.39L at the 6-10 years of duration. The mean value of FVC in patients with disease duration of more than 10 years has increased to 2.45L. In patient females, FVC mean values have decreased from 2.0 L at 1 year of duration to 1.72L at more than 10 years of duration but the difference in the mean values of FVC in different categories of disease duration has not been found to be statistically significant in both male and female bronchial asthma patients.

b) **Forced expiratory volume in one second (FEV1)**

In patient males, FEV1 has shown a trend of decrease with increasing duration of disease. The mean value of FEV1 decreased as the duration of disease increased. Patient
males had mean value of 1.49 L at less than 1 year of duration and it decreased to 1.25 L at 6-10 years of duration. At more than 10 years of duration, the mean value of FEV1 has improved to 1.34 L. In patient females, mean value of FEV1 up to one year of duration was 1.29 L and it decreased to 0.99 L at more than 10 years of duration of disease. The difference in the mean values of FEV1 in different categories of disease duration has not been found to be statistically significant in both males and females.

c) Ratio of forced expiratory volume in one second to forced vital capacity (FEV1 / FVC)

In males, the mean FEV1/FVC value was found to be 57.99 up to 1 year of duration of disease. It decreased to 51.14 at 6-10 years of duration. In patients with more than 10 years of disease duration the mean value has increased to 57.90.

In females also FEV1/FVC has shown a decreasing trend with increasing duration of disease. It decreased from 65.01 at up to 1 year of duration to 58.18 at more than 10 years of duration. Mean values of FEV1/FVC differed significantly in different categories of disease duration in males.

d) Forced expiratory flow (FEF) 25-75 %

In males, mean values decreased continuously from 1.98 L/s at less than one year of duration to 0.70 L/s at 6-10 years of duration. At more than 10 years of duration, mean value has increased to 0.84 L/s. In females FEF 25-75 % has decreased consistently with increase in duration of disease. It decreased from 1.05 L/s at less than one year of duration to 0.61 L/s at more than 10 years of duration. The difference in the mean values of
FEF25-75% in different categories of disease duration has not been found to be statistically significant in both male and female patients.

e) Peak expiratory flow rate (PEFR)

In males, mean values decrease from 2.92 L/s at less than 1 year of duration of disease to 2.19 L/s at 6-10 years of duration of disease and after that it has improved in patients with more than 10 years of duration. In females PEFR mean values decreased from 2.22 L/s at less than 1 year of duration to 1.63 L/s at more than 10 years of duration of disease. The difference in the mean values of PEFR with increasing duration of disease has been found to be statistically significant in females.

f) Forced expiratory volume in three seconds (FEV3)

In males, FEV3 decreased from 2.08 L to 1.88 L with increase in duration of disease from less than one year duration of asthma to 6-10 years of duration. With further increase in duration i.e. > 10 years, value of FEV3 improved. It increased to 2.03 L in females, decrease in FEV3 continued with increase in duration of disease. It decreased from 1.75L at less than one year of duration to 1.46 L at more than 10 years of duration of disease. The mean values did not vary significantly in different categories of disease duration in both males and females.

g) Ratio of Forced expiratory volume in three seconds to forced vital capacity (FEV3/FVC)

In males, the mean value of FEV3 decreases with increasing duration FEV3/FVC decreased from 82 at less than one year of duration to 77.46 at 6-10 years of duration of
disease. Ratio improved at more than 10 years of disease duration. In females also, trend of decrease has been observed up to 6-10 years duration followed by slight improvement in females with more than 10 years of disease duration. The mean values of FEV3/FVC did not differ significantly in different categories of disease duration in both males and females.

h) Lung age

Mean value of lung age increased with duration of disease in both males and females. In males, lung age increased from 75.68 years at less than 1 year of duration to 79.22 years at 6-10 years of duration. It decreased at the duration of more than 10 years. In females, lung age increased from 63.33 years at less than 1 years of duration to 70.0 years at more than 10 years of duration. The difference in the mean lung age in different categories of disease duration has not been found to be statistically significant in both male and female patients.

VIII. Severity of asthma and pulmonary functions

Table 49 gives frequency distribution of bronchial asthma patients classified in three categories according to severity score. Table 50 and 51 (fig. 52-59) present mean values of pulmonary function variables according to severity of disease in male and female bronchial asthma patients.

a) Forced vital capacity (FVC)

In males, mean values decrease continuously from 2.93 L at severity score of 5-6 to 1.93 L at the severity score of >9. In females also, FVC mean values decreased
from 2.12 L at severity score of 5-6 to 1.51L at severity score of >9. The difference in the mean values of FVC with increasing level of severity score has been found to be statistically significant in both males and females.

b) Forced expiratory volume in one second (FEV1)

In males, mean FEV1 value decreased markedly with increasing severity score. It decreased from 1.72 L at severity score of less than 6 to 0.84 L at severity score of more than 9. In females also, FEV1 decreased markedly with increasing severity score. It decreased from 1.60 L at severity score of <6 to 1.20L at severity score of >9. The mean values of FEV1 differed significantly according to increasing severity score of disease in males.

c) Ratio of forced expiratory volume in one second to forced vital capacity (FEV1/FVC)

In males, the mean value of FEV1/FVC decreased from 57.9 to 50.21 as severity score increased from <6 to>9. In females, FEV1/FVC values decreased from 65.08 at severity score of <6 to 53.34 at severity score of >9. The decrease in FEV1/FVC has been found to be statistically significant in females.

d) Forced expiratory flow (FEF) 25-75%

In males with mild form of disease i.e. at severity score of <6 ,the mean value of FEF 25-75% was 1.19 L/s then it decreased with increasing severity to 0.48 L/s at severity score level of >9 . In females with 7-9 severity score of disease FEF 25-75% was 1.67L/s and it decreased to 1.38L/s in patients with severity of disease score >9. The
variation in the mean values of FEF 25-75% in different categories of disease severity has not been found to be statistically significant in both males and females.

e) Peak expiratory flow rate (PEFR)

In males the mean PEFR decreased from 3.22 L/s at severity score of 5-6 to 1.82 L/s at severity score of >9. In females the mean PEFR decreased from 2.35 L/s at severity score of 5-6 to 1.24 L/s in patients with severe score > 9. The mean values of PEFR differed significantly with increase in severity of disease in both males and females.

f) Forced expiratory volume in three seconds (FEV3)

In males FEV3 decreased from 2.42 L at severity score of 5-6 to 1.92 L in patients with severity score of 7-9 and in patients with severity score > 9 the mean value of FEV3 further decreased to 1.42 L. In females, the mean value of FEV3 decreased from 1.87 L at severity score of 5-6 to 1.23 L at severity score of >9. The difference in the mean values of FEV3 according to different categories of severity of disease has been found to be statistically significant in both males and females.

g) Ratio of forced expiratory volume in three seconds to forced vital capacity (FEV3/FVC)

In males with severity score of 5-6, the mean value of FEV3/FVC ratio was found to be 88.8 and it decreased to 75.81 in patients with severity score >9. In females, the mean value of FEV3/FVC decreased from 87.5 at severity score of 5-6 to 81.57 in patients with severity score of >9. The difference in the mean values of FEV3/FVC in
categories according to severity of disease has not been found to be statistically significant.

h) Lung age

In males, the mean lung age increased from 64.81 years at severity score of 5-6 to 94.94 years in patients with severity score of > 9 showing deterioration in lung functions with increasing severity. In females patients also the mean lung age increased from 54.50 years at severity score of 5-6 to 81.08 years in patients with severity score of > 9. The increase in lung age with increasing severity was statistically significant in both males and females.