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Autonomic Dysfunction in Heart Rate Variability and Spectral Disturbances in COPD Patients:

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ABSTRACT:

Background: *This research examined autonomic dysfunction in heart rate variability and spectral disturbances in COPD patients. The research included 100 COPD patients and 100 healthy as control. The research covered Mild & Moderate COPD patients. Excludes severe and very severe COPD patients also avoided sand miners and passive smokers. Study used case-control design. The result revealed that COPD sufferers had a lower FEV1% (1.90.39) than controls. COPD patients had a lower FVC% (56.428.41) than controls. COPD sufferers had a 2.750.62 higher RV (L) than controls. COPD sufferers had a 2.750.62 higher TLC (L) than controls. Cases and controls HRV and frequency parameters (LF/HF) ratio shows a considerable difference, although LF nu and HF nu indicate no difference. A high ratio of low to high frequency activity indicates parasympathetic activation. Comparing Time Domain Parameters, HRV of Cases and Controls, the mean RR interval of the control group appears to rise, giving the appearance that the smaller mean RR interval in cases reflects a fast heart rate due to a shift toward sympathetic activity. COPD patients have lower HRV, which indicates ANS dysfunction with sympathetic hyperactivity. Regulated breathing increases parasympathetic activity and HRV, although not much. So the study will try to show that weather controlled breathing slow and deep will affect the ANS controlling of the heart variables are not.*

Materials & Methods: Research techniques are methods for tackling research problems in an organized and methodical manner. Researchers employ a range of procedures, including interviews, observation, and observational data collection, to obtain new information from the subject. To achieve our research objectives, the researcher used an evaluative strategy. This study was duration based case control study, carried out for a period of one year on clinically confirmed cases of COPD patients visiting OPD and in patients at Index Medical College & Hospital in Indore. A total of 200 subjects are recruited, 100 COPD patients as interventional and 100 healthy as controls. Easy on PC programme was used to get the flow volume curve, analyze it, and determine the % expected value for FEV1 and FVC. All patients had their FEV1 and FVC measured, and all COPD patients had their FEV1% computed using the GOLD standard criteria. HRV was analyzed by using the VarioWin-HR analysis programme.

Results: The chosen studies found a substantial drop in HRV in COPD patients, as measured by indices that evaluate parasympathetic activity in addition to dealing with global autonomic regulation. We also discovered that supervised exercise may help COPD patients decrease these negative consequences. Pulmonary function result reveals that FEV1 was found to be less in COPD cases. FEV1 % was found to be less in COPD cases. FVC % was found to be less in COPD cases. RV (L) was found to be greater than in COPD cases. TLC (L) was found to be greater than in COPD cases. TLC (L) was found to be greater than in COPD cases. In comparison to healthy people, COPD patients had a faster heart rate (p 0.05) and lower average NN, SDNN, RMSSD, pNN50, HF, LF, and TP (all p 0.05), but a comparable QTc interval (p = 0.185). SDNN and TP (both p 0.05) rose throughout rehabilitation, as did the outcomes of the 6MWT, ISWT, and SGRQ (both p 0.05).

Conclusion: Following regulated breathing, there is a little increase in parasympathetic activity and a rise in HRV, although these effects are not statistically significant. As a consequence, it is difficult to determine if regulated breathing had any effect on this study. Regularly practised controlled, slow, and deep breathing improves ANS control of HR.

Key Words: *COPD, Sympathetic, Heart Rate, Breathing, Autonomic, Hyperactivity, Nervous.*

INTRODUCTION:

Chronic obstructive pulmonary disease (COPD) is a type of progressive lung illness that can be prevented and treated. Discomfort from COPD includes long-term respiratory symptoms and airflow restriction like shortness of breath and a cough that produces mucus or does not produce mucus. COPD worsens over time, making it more difficult to do routine activities such as walking or dressing properly [1]. Emphysema and chronic bronchitis are the two most frequent diseases associated with COPD, and they have long been considered the two basic COPD phenotypes. Emphysema is a structural issue whereas Chronic bronchitis is a mucus issue. They can coexist without causing airway limitation. It is the only anatomical anomaly that can limit airflow in a substantial number of people, and it can also exist without any restriction of airflow in a significant number of those same people [2].

According to the findings of the previous studies, ischemic heart disease, stroke, and chronic obstructive pulmonary disease (COPD) are the primary causes of early death among people with NCDs. COPD is a prevalent, preventable, and treatable no communicable disease (NCD) characterized by persistent respiratory symptoms and airflow limitation due to abnormalities in the airway and (or) alveoli. The American Thoracic Society finds COPD patients have higher airway resistance when compared to healthy people, even when they do not have clinically obvious respiratory insufficiency. This increased airway resistance may result in increased work of breathing, which may have an effect on autonomic nerve function even in the absence of hypoxic brain injury. The interaction between the disturbances of the cardiopulmonary system and the reaction of its regulatory systems, particularly the autonomic nervous system, is reflected in spontaneous fluctuations of heart rate [3].

The cardiovascular disorders in COPD patients are facilitated by autonomic dysfunction, which is most likely caused by chronic hypoxia. This autonomic dysfunction manifests itself as an increased resting heart rate, as well as an increased risk of arrhythmias, abnormal conduction, and ectopic beats because the autonomic nervous system is responsible for the maintenance of involuntary vital parameters such as blood pressure, heart rate, breathing, etc. HRV, baroreceptor sensitivity, muscle sympathetic nerve activity, and sympathetic skin response are some of the parameters that can be measured in the temporal and frequency domains, respectively [4].

Cardiac autonomic dysfunction, which is known to be altered in COPD patients, is thought to play a role in the development of arrhythmias, as previously stated [5]. Also the abnormal activity of autonomic nerve innervations might contribute to airway narrowing in COPD, and that abnormal activity may be relevant to the development of COPD as well [6].

DISCUSSION:

This study was investigated the autonomic dysfunction in heart rate variability and spectral disturbances in COPD patients, it was a Case Control Study. Result revealed that age group of majority of the Cases were 41% from 55 to 65 years and in Controls 39% from 55 to 65 years, only 8% from 35 to 45 yrs. in Cases and in Controls it is 11%. Majority of the cases have secondary education 40% and in controls 37% with secondary education and only 4% were illiterate in cases and in controls were 10%. Majority of the cases were retired employees 38% and in controls 30% were retired employees and only 6% were coolies in cases and in controls were 9%. Regarding BMI majority of the cases (62%) were have BMI

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between 25-30 and in Controls 67% were earning between 25-30 and only 15% were have less than 25 BMI in cases and in controls were 17%. Majority of the cases (50%) were have height between 160-170 cm and in Controls 61% have height between 160-170 cm and only 4% were have more than 180cm in cases and in controls were 10%. Regarding weight majority of the cases (60%) were have weight between 50-70kg and in Controls 67% were have weight between 50-70kg and only 10% were have more than 90 kg weight in cases and in controls were 13% [6].

We took note of their overall features as well as their exacerbation history and the combined GOLD 2011 COPD categories. Patients were given the option to come in for follow-up appointments three times over the course of one year. During the follow-up visits, their level of adherence to the inhaled therapy that was prescribed in accordance with GOLD 2011 was assessed [7]. The percentage of patients who continued with the prescribed therapy was determined to be 81.9%. Even though these individuals had never been diagnosed with COPD before, a significant number of them fell into the GOLD C and D categories and had the frequent exacerbate phenotype. They were often administered an excessively long course of therapy. We believe that patients who have just been diagnosed with COPD should undergo rigorous evaluations, and that every effort should be taken to ensure that they are treated in a manner that is in line with the recommendations of the most important COPD guidelines [8].

Pulmonary function test results of cases and controls:

Pulmonary function result reveals that FEV1 was found to be less in COPD cases with a mean of 1.99±0.39 than controls. FEV1 % was found to be less in COPD cases with a mean of 62.07±4.83 than controls. FVC % was found to be less in COPD cases with a mean of 56.42±8.41 than controls. RV (L) was found to be greater than in COPD cases with a mean of 2.75±0.62than controls. TLC (L) was found to be greater than in COPD cases with a mean of 2.75±0.62than controls. TLC (L) was found to be greater than in COPD cases with a mean of 0.47±0.04 than controls [9].

Comparison between heart rate variability and frequency parameters of cases and controls:

Comparison between heart rate variability and frequency parameters of cases and controls. While the LF/HF ratio reveals a significant difference between the patients and the controls, other metrics, such as LF nu and HF nu, show only a very little difference between the cases and the groups. A high ratio of low to high frequency activity in the instances demonstrates an increase in parasympathetic activity [10].

We also discovered that supervised exercise may help COPD patients decrease these negative consequences. It was also found that the use of non-invasive ventilation in these patients may help to the alleviation of respiratory symptoms while having no adverse effects, and may even produce beneficial responses in cardiac autonomic control. The findings suggest that further research is needed to guide future medicines to enhance the treatment of cardiovascular system in respiratory disorders [11].

Comparison between time domain parameters heart rate variability of cases and controls:

Comparison between time domain parameters heart rate variability of cases and controls, the mean RR interval of the control group seems to have an increase. It gives the impression that the smaller mean RR interval in instances demonstrates a rapid heart rate in those cases as a result of a change in balance toward sympathetic activity [12].

Correlation between mean RR interval and FEV1 %:

Correlation between mean RR interval and FEV1%. It demonstrates that there is a positive association between the cases and the controls. It suggests that there are a higher number of instances that fall under the 95% limit. When the FEV1% rises, there is also an increase in the frequency of instances in which there is an increase in the mean RR interval [13].

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Correlation between mean SDNN and FEV1 %:
There is a positive relationship between FEV1% and SDNN for both groups. The data below suggests that roughly half of all instances are contained inside the 95% limits. In addition, a rise in FEV1% is associated with an increase in SDNN in around half of all cases [14]

Correlation between mean RMSSD interval and FEV1 %:
There is a positive correlation between FEV1% and RMSSD for both of these categories. According to the statistics shown above, about fifty percent of all incidents fall within the 95% confidence levels. In addition to this, research has shown that an increase in FEV1% is linked to an increase in RMSSD in almost half of all instances.

The findings are concordant with Michel Silva Reis et. al (2010). The current study sought to determine the effect of respiratory muscle strength on autonomic regulation in these individuals. This research included ten chronic obstructive pulmonary disease patients (699 years; FEV1/FVC 5912% and FEV1 411% expected) and nine age-matched healthy volunteers (645 years) [15]. The electrocardiograph was used to measure heart-rate variability (HRV) at rest and during the respiratory sensual arrhythmia manoeuvre (RSA-M).When compared to healthy volunteers, patients with chronic obstructive pulmonary disease had poorer cardiac autonomic regulation at rest and during RSA-M (p0.05). Furthermore, substantial and positive associations were discovered between maximum inspiratory pressure (MIP) and the inspiratory-expiratory difference (IE) ($r = 0.60$, p0.01). At rest, patients with chronic obstructive lung disease had an abnormal sympathetic-vagal balance. Furthermore, in chronic obstructive pulmonary illness, cardiac autonomic modulation of heart rate was linked to inspiratory muscle weakening. Future research applications of respiratory muscle training may bring to light a potentially effective target for rehabilitation based on this information [16].

Comparison Between heart Rate Variability Frequency Parameters of Cases before and after Intervention: Comparison between heart rate variability and frequency parameters of cases and controls. While the LF/HF ratio reveals a significant difference between the patients and the controls, other metrics, such as LF nu and HF nu, show only a very little difference between the cases and the groups. A high ratio of low to high frequency activity in the instances demonstrates an increase in parasympathetic activity [17].

Comparison between Time Domain Parameters Heart Rate Variability of cases before and after Intervention:
The paired T test was used to analyse the time domain parameters of COPD patients, including mean RR interval, SDNN, and RMSSD, before and after regulated breathing pattern. P-values were discovered for each of the parameters, and a p value of less than 0.05 was considered to be statistically significant. Before and after a regulated breathing pattern, there is a statistically significant difference between the SDNN in COPD patients, as measured by the p value of 0.01.When comparing the mean RR interval of COPD patients before and after a session of regulated breathing; an apparent increase might be seen after the session [18]. It is possible to deduce from this that the participants' heart rates slowed down after the controlled breathing session because there was a change in the equilibrium away from sympathetic activity and toward parasympathetic action [19].

After the CB session, there was an apparent increase in SDNN and RMSSD in COPD patients, as seen in the bar graph that follows. If your SDNN is high, it suggests that your HRV is more variable, and if your RMSSD is high, it suggests that your parasympathetic activity is higher. The noticeable increase in SDNN and RMSSD that occurred in COPD patients after a CB session. If your SDNN is high, it suggests that your

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heart rate variability is also high, and if your RMSSD is high, it suggests that your parasympathetic activity is also high [20].

SAMPLING TECHNIQUE:

The research was done in Index Medical College and Research Centre Indore India. The total subjects were 200, 100 was control and 100 was experimental for this study. Selection of a representative sample of the investigated population (S.K. Sharma) [21]. One of the sampling process's objectives is to choose a sample that accurately represents the population from which it was drawn. Random sampling is predicated on the premise that each sample has an equal chance of being chosen.

INCLUSION CRITERIA:

- Males and females without COPD (Control).
- COPD patients in Mild and Moderate stages (Experimental).

EXCLUSION CRITERIA:

- COPD patients in the severe and very severe stages.
- Other pulmonary conditions
- Diabetes-related neuropathy
- Hypertension
- Neurological disorders
- Cardiac disorders such as arrhythmias, coronary artery disease, and conduction abnormalities
- Smokers, alcoholics, and people who work the night shift also who were on medications that could interfere.

Ethical Committee Research Approval:

Proper research approval was taken from ethical committee of the research division. The research approval number for said research is *MU/Acm/PhP/2020/02.*

Funding Agency:

The research was not funded by any organization.

PROCEDURE:

They were told in their own language the details of the research. Each participant signed an informed consent form in their own language. The height was determined using a stadiometer, which was exact to 1 cm, and the weight was determined using a digital scale that was accurate to 0.1 kg. Body mass index was calculated using the formula: weight (kg)/height (m^2) [22].

The respiratory, cardiovascular, abdominal, and central nervous systems were all clinically checked throughout the systemic examination, and all patients were recorded. Following a clinical assessment, participants underwent pulmonary function tests and a heart rate variability analysis [23].

MATERIALS & METHODS:

Easy on PC Spirometer

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PRINCIPLE:
Flow sensing Spirometers using ultra Soundwaves.

Recording:
How to take the exam was taught to participants and shown. Easy on PC programme was used to get the flow volume curve, analyze it, and determine the % expected value for FEV1 and FVC. All patients had their FEV1 and FVC measured, and all COPD patients had their FEV1% computed using the GOLD criteria (1). Moderate stages (Post bronchodilator 50% > FEV1% 80%) and Mild stages (Post bronchodilator FEV1% 80%). All Controls had FEV1% levels that were within normal ranges after being assessed [24].

Placement of electrodes & HRV recording of heart: Equipment:
The heart rate variability analysis study was done using VarioWin_HR, apc-based HRV analysis system. This HRV analysis equipment was validated using the GOLD standards published by the American Heart Association and the European Society of Cardiology [25]. The North American Society of Pacing and Electrophysiology and the Board of the European Society of Cardiology adopted the Task Force 1996 recommendations for HRV recording.

Data Acquisition & Analysis:
To minimize the impact of circadian rhythm, all participants' room temperatures were only recorded between 8 and 11 am, between 21 and 23 degrees Celsius. Data was gathered using the built-in software at a sample rate of 500 cycles/sec from the standard lead II recording. Using analysis software, the ECG signal was digitalized and stored on the computer. Using the VarioWin-HR analysis programme, HRV analysis of the acquired data was performed. The final results were shown on an A4 sheet with explanation; the programme recognizes all R waves and computes the R-R interval from the collected data. R-peak detection and RR calculation were carried out automatically and precisely by the Vario Win HR programme [26].

Record during controlled breathing:
Only COPD patients were included in the controlled breathing recording. After the first measurement, students learned about regulated deep breathing, which requires taking slow, deep breaths for 10 seconds and six breaths each minute, with 5 seconds of inspiration and 5 seconds of expiration [26]. They were instructed to rest for ten minutes after the lecture before performing the controlled breathing technique. When they were prepared, the second HRV recording took place during their regulated breathing exercise and lasted 5 minutes. HRV was used to gauge autonomic activity when at rest. Two categories of parameters were found through HRV analysis:

1) **Time Domain Parameters**
2) **Frequency Domain Parameters**

Time Domain Indices:
From the R-R interval data, the following time domain variables were calculated.

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i) MEAN R-R INTERVAL:

All NN (normal to normal RR interval) intervals are represented by the mean of these intervals. It indicates sympathovagal activity since it fluctuates inversely with the mean heart rate in a certain physiological condition.

ii) SDNN:

It displays the average standard deviation over all NN intervals. It serves as a measure of the heart's overall variability. Additionally, it reflects HRV at both low and high frequencies.

iii) NN50:

High frequency heart rate fluctuation is identified. It indicates how many consecutive NN interval pairs there are across the whole recording that are separated by more than 50 ms.

iv) pNN50:

It is the percentage derived by dividing the total number of NN intervals by the NN50 count. This provides the NN50 count and high frequency variance in heart rate.

v) RMSSD:

In the lead II ECG, it is the square root of the mean of the sum of the squares of differences between neighbouring NN intervals. This causes the heart rate's high frequency changes, which are a gauge of the parasympathetic response.

Frequency Domain Measures:

Power spectral density (PSD) analysis provides fundamental information about how power (i.e. variance) varies with frequency. Proper mathematical algorithms can only obtain an estimate of the true PSD of the signals, regardless of the method used. The entire data set was divided into overlapping sections for spectral analysis, and each section was subjected to Fast Fourier Transformation, with the average taken for periodogram values [27]. HRV frequency domain measurements are as follows:

1) **Low Frequency Power (LF):**
   Signals have a frequency range of 0.04 to 0.15 Hz. Both a sympathetic and parasympathetic tone is indicated by LF.

2) **High Frequency Power (HF):**
   The HF power spectrum spans the frequency range of 0.15 to 0.4 Hz. Parasympathetic effect is indicated by HF.

3) **LF Norm (nu):**
   It is low frequency component expressed in normalized units. LF nu is calculated by the formula, LF nu = LF/ (Total power–VLF) X 10.

4) **HF Norm (nu):**
   It is high frequency component expressed in normalized units. HFnu is calculated using the formula, HFnu = HF / (Total power – VLF) X 100.

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5) **F/HF Ratio:**
   A measurement of sympathovagal balance is the LF/HF ratio. It serves as a more reliable gauge of spectral powers. While a greater LF/HF ratio denotes a rise in sympathetic tone, a lower LF/HF ratio indicates a rise in parasympathetic tone.

SUMMARY:

Pulmonary function result reveals that FEV1 was found to be less in COPD cases with a mean of 1.99±0.39 than controls. FEV1 % was found to be less in COPD cases with a mean of 62.07±4.83 than controls. FVC % was found to be less in COPD cases with a mean of 56.42±8.41than controls. RV (L) was found to be greater than in COPD cases with a mean of 2.75±0.62 than controls. TLC (L) was found to be greater than in COPD cases with a mean of 2.75±0.62 than controls. TLC (L) was found to be greater than in COPD cases with a mean of 0.47±0.04 than controls [28].

The LF/HF ratio reveals a significant difference between the patients and the controls, other metrics, such as LF nu and HF nu, show only a very little difference between the cases and the groups.. A high ratio of low to high frequency activity in the instances demonstrates an increase in parasympathetic activity.

The mean RR interval of the control group seems to have an increase; It gives the impression that the smaller mean RR interval in instances demonstrates a rapid heart rate in those cases as a result of a change in balance toward sympathetic activity.

The Correlation between mean RR interval and FEV1% demonstrates positive association between the cases and the controls. It suggests that there are a higher number of instances that fall under the 95% limit. When the FEV1% rises, there is also an increase in the frequency of instances in which there is an increase in the mean RR interval. Study shows a positive relationship between FEV1% and SDNN for both groups. A high ratio of low to high frequency activity in the instances demonstrates an increase in parasympathetic activity [29].

The paired T test was used to analyse the time domain parameters of COPD patients, including mean RR interval, SDNN, and RMSSD, before and after regulated breathing pattern. P values were discovered for each of the parameters, and a p value of less than 0.05 was considered to be statistically significant. Before and after a regulated breathing pattern, there is a statistically significant difference between the SDNN in COPD patients, as measured by the p value of 0.01.When comparing the mean RR interval of COPD patients before and after a session of regulated breathing; an apparent increase might be seen after the session. It is possible to deduce from this that the participants' heart rates slowed down after the controlled breathing session because there was a change in the equilibrium away from sympathetic activity and toward parasympathetic action [30].

After the CB session, there was an apparent increase in SDNN and RMSSD in COPD patients, as seen in the bar graph that follows. If your SDNN is high, it suggests that your HRV is more variable, and if your RMSSD is high, it suggests that your parasympathetic activity is higher [31]. The noticeable increase in SDNN and RMSSD that occurred in COPD patients after a controlled breathing session. If your SDNN is high, it suggests that your heart rate variability is also high, and if your RMSSD is high, it suggests that your parasympathetic activity is also high [32].

RESULTS AND OBSERVATIONS:

Figure-1: Depicts that the age group of majority of the Cases were 41% from 55 to 65 years and in Controls 39% from 55 to 65 years only 8% from 35 to 45 yrs. in Cases and in Controls it is 11%.

Figure-2: Depicts that the in cases and controls males constituted higher percentage than females in controls, 1% of the samples were transgender.

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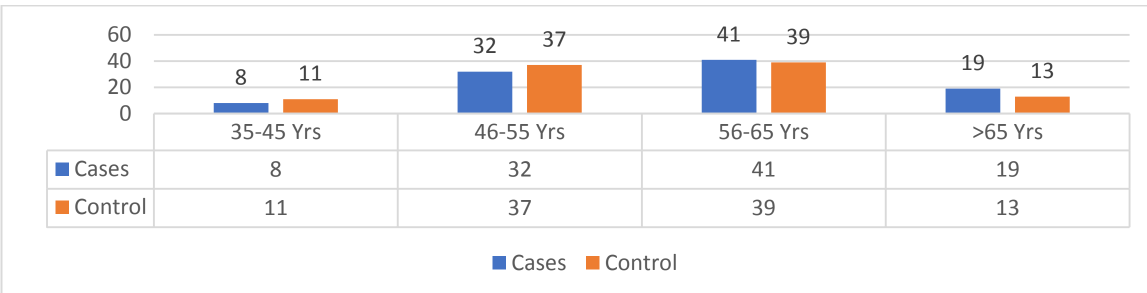
Figure-3: Depicts that, majority of the cases have secondary education 40% and in controls 37 % with secondary education and only 4% were illiterate in cases and in controls were 10%.

Figure-4: Depicts that, majority of the cases were retired employees 38% and in controls 30% were retired employees and only 6% were coolies in cases and in controls were 9%.

Figure-5: Depicts that, majority of the cases (42%) were earning between 10001 to 20000 and in Controls 37% were earning between 10001 to 20000 and only 12% were earning less than 10000 in cases and in controls were 14%.

Figure-6: Depicts that, majority of the cases (62%) were have BMI between 25-30 and in Controls 67% were earning between 25-30 and only 15% were have less than 25 BMI in cases and in controls were 17%.

Figure 1:



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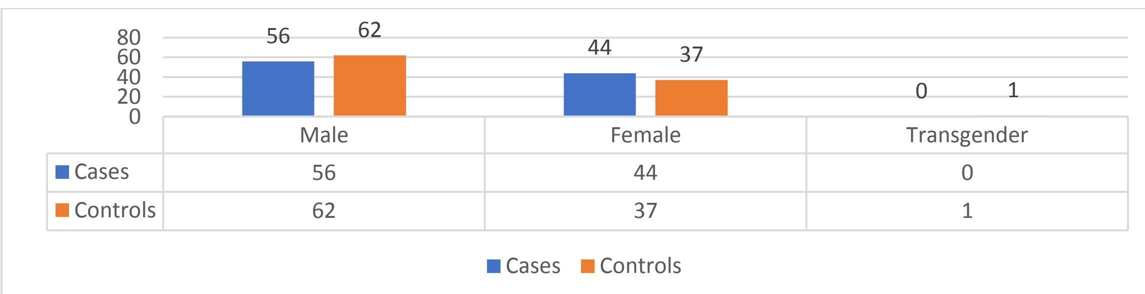

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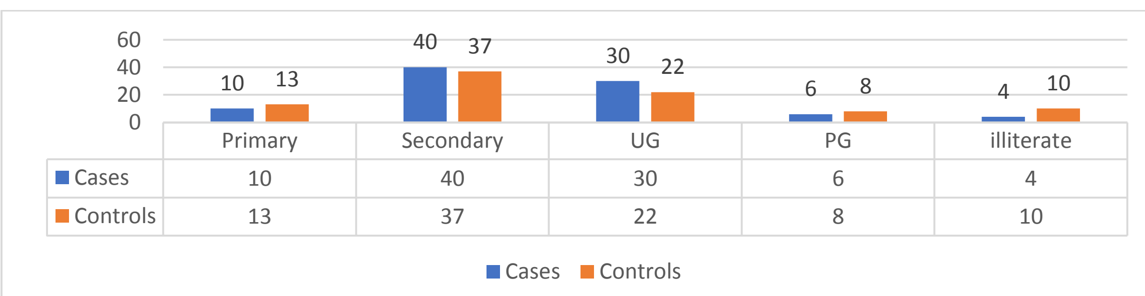

Figure 4:

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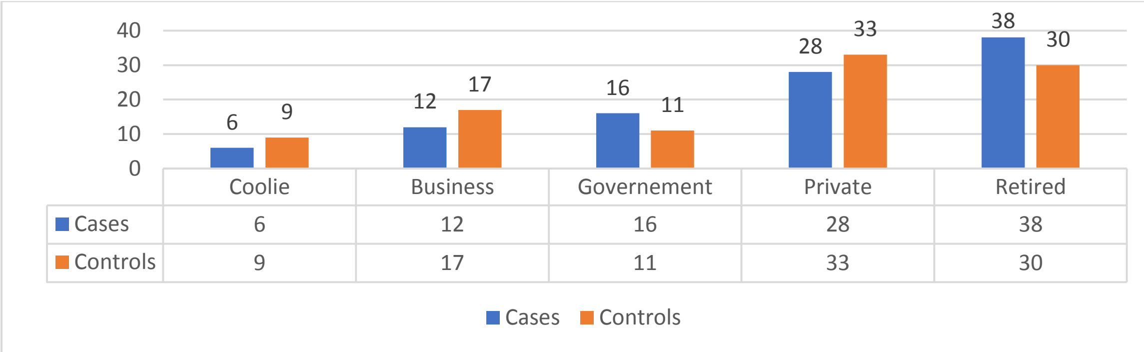

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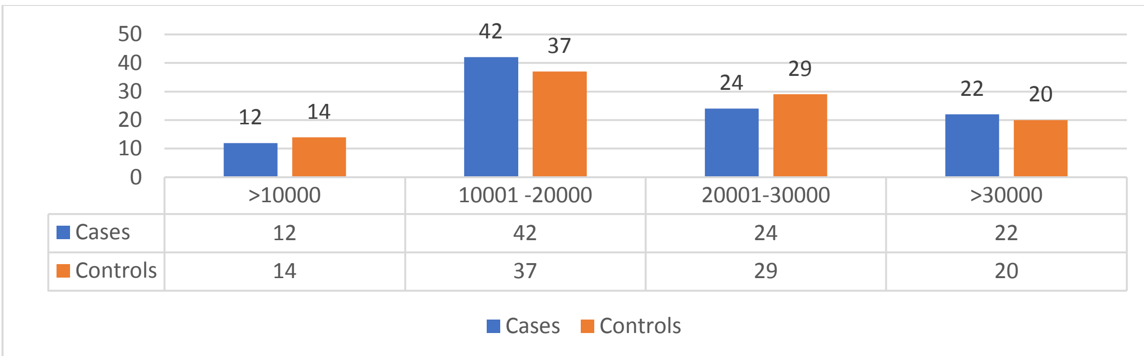

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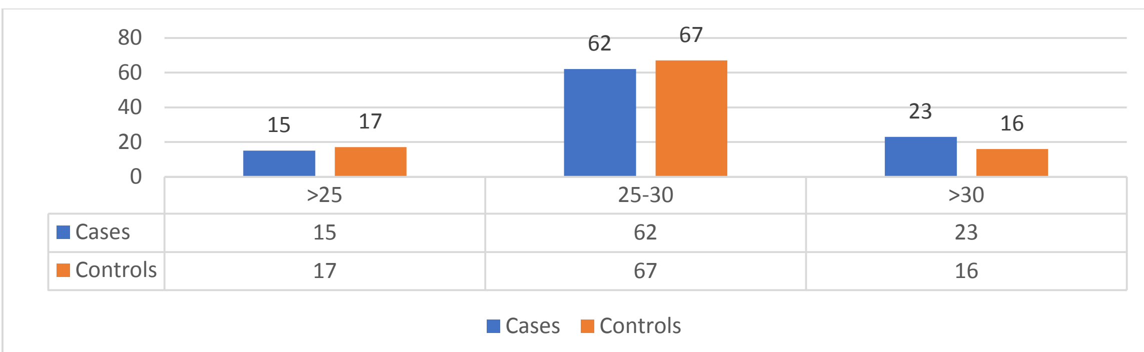

Figure-7: Depicts that, majority of the cases(50%) were have height between 160-170-cm and in Controls 61% have height between 160-170-cm and only 4% were have more than 180 cm in cases and in controls were 10%.

Figure-8: Depicts that, majority of the cases(60%) were have weight between 50-70kg and in Controls 67% were have weight between 50-70kg and only 10% were have more than 90 kg weight in cases and in controls were 13%.

Figure-9: Pulmonary function result reveals that FEV1 was found to be less in COPD cases with a mean of 1.99±0.39 than controls. FEV1 % was found to be less in COPD cases with a mean of 62.07±4.83than controls.

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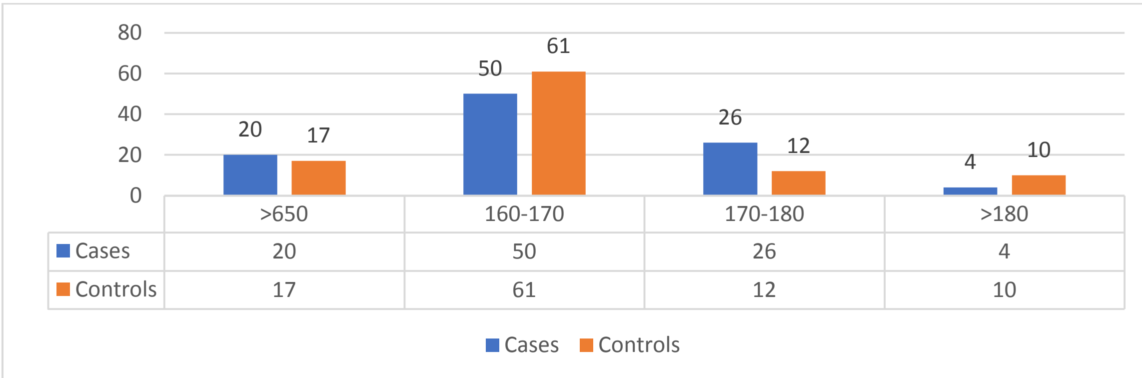
than in COPD cases with a mean of 2.75±0.62 than controls. TLC (L) was found to be greater than in COPD cases with a mean of 0.47±0.04 than controls.

Figure 7:



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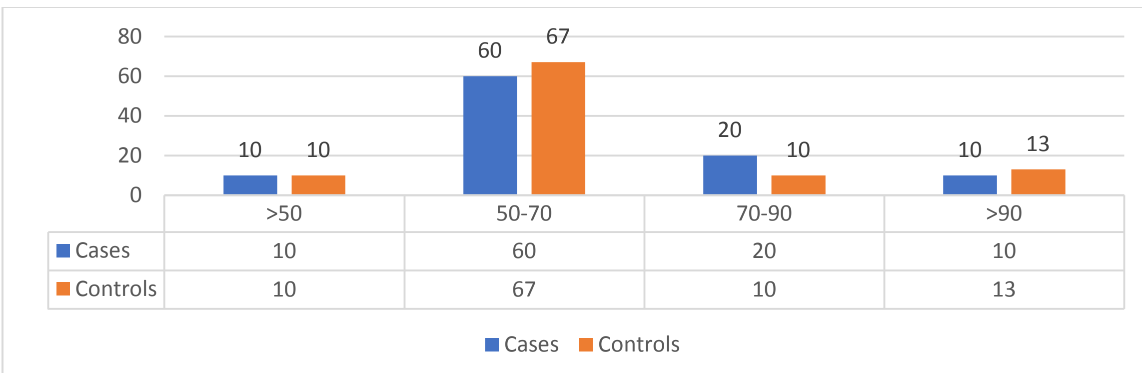

Figure 10: Reveals that the Comparison between heart rate variability and frequency parameters of cases and controls. While the LF/HF ratio reveals a significant difference between the patients and the controls, other metrics, such as LF nu and HF nu, show only a very little difference between the cases and the groups. A high ratio of low to high frequency activity in the instances demonstrates an increase in parasympathetic activity.

Figure 9:

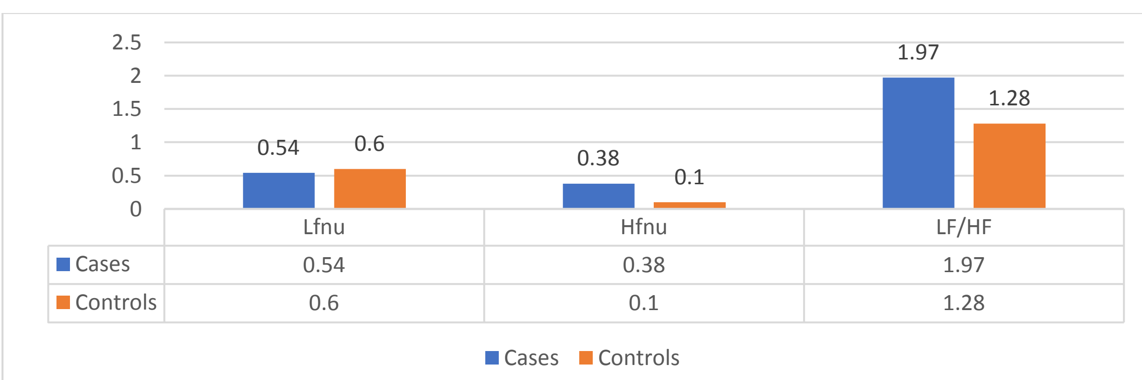

Figure 10:

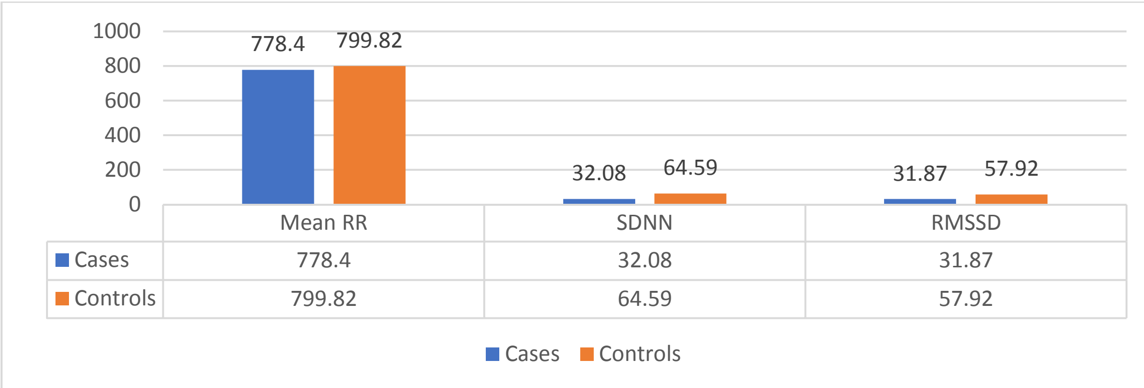

Figure 11: Reveals that comparison Between Time Domain Parameters Heart Rate Variability of Cases And Controls, the mean RR interval of the control group seems to have an increase, It gives the impression that the smaller mean RR interval in instances demonstrates a rapid heart rate in those cases as a result of a change in balance toward sympathetic activity.

Figure 12: Illustrates the apparent disparity between patients and controls with regard to SDNN and RMSSD. Both metrics seem to have decreased in COPD patients as a result of this study. In situations with a low SDNN, there is a reduction in the heart rate variability. Cases with low RMSSD indicate a reduction in the parasympathetic activity present in them. Positive correlation between FEV1% and RMSSD for both of these categories was seen. About fifty percent of all incidents fall within the 95% confidence levels. In addition to this, research has shown that an increase in FEV1% is linked to an increase in RMSSD in almost half of all instances.

Figure 11:

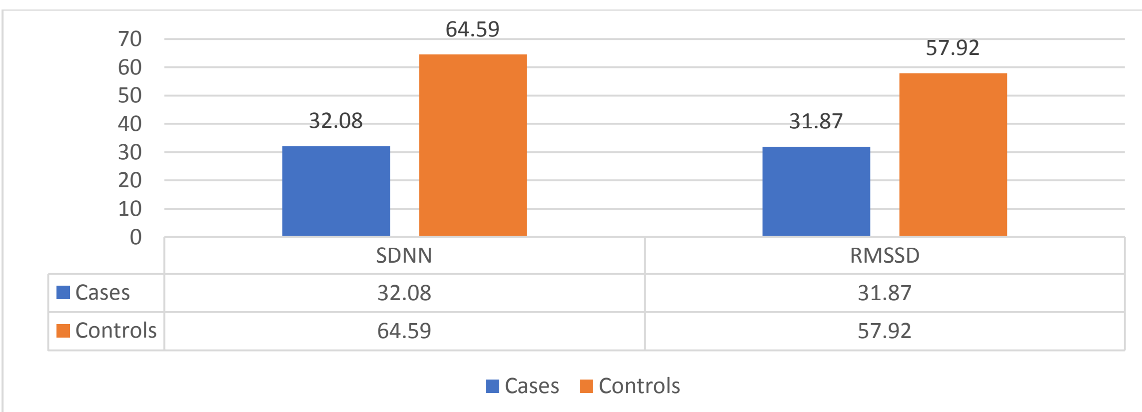

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Figure 12:

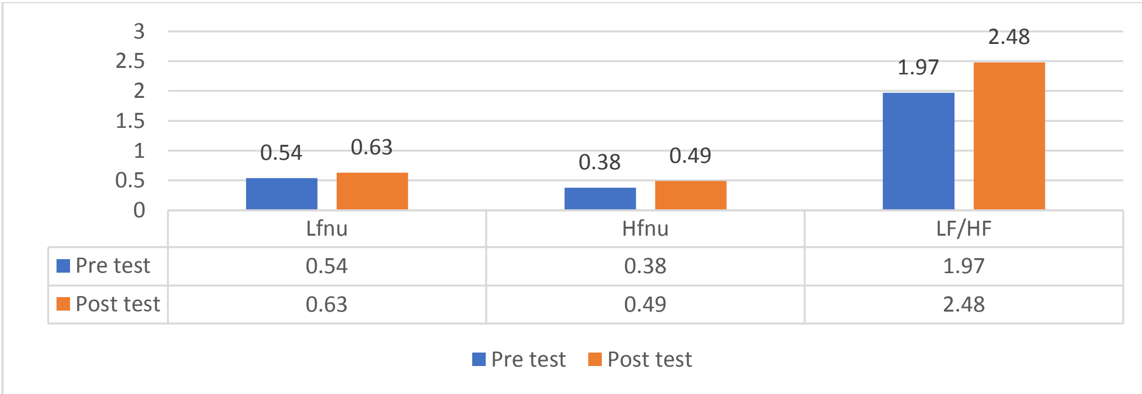
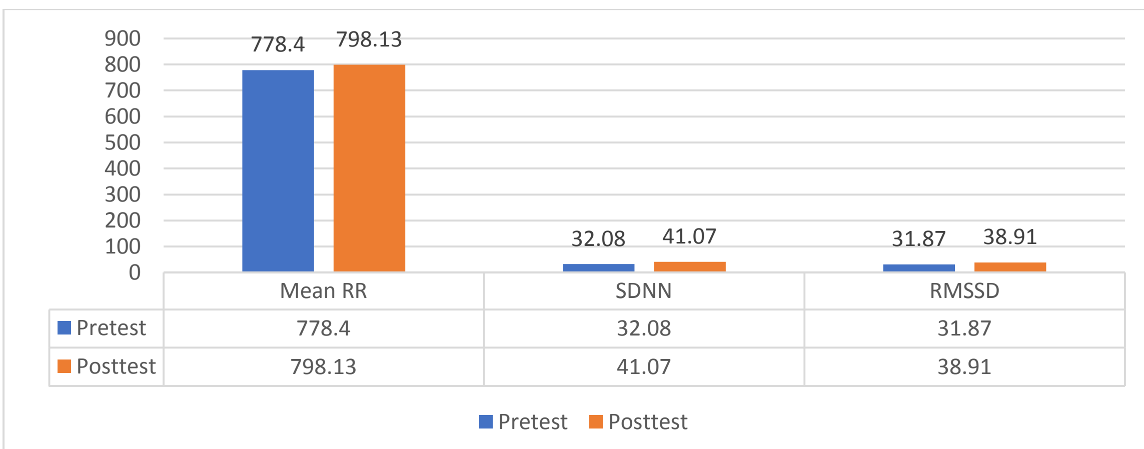


Figure 13: Reveals that the Comparison between heart Rate Variability and Frequency Parameters Of cases and controls. While the LF/HF ratio reveals a significant difference between the patients and the controls, other metrics, such as LF nu and HF nu, show only a very little difference between the cases and the groups.. A high ratio of low to high frequency activity in the instances demonstrates an increase in parasympathetic activity.

Figure 13:



CONCLUSION:

This study comes to the conclusion that COPD patients have reduced heart rate variability, which is indicative of ANS dysfunction with sympathetic hyperactivity. Following regulated breathing, there is a little increase in parasympathetic activity and a rise in heart rate variability, although these effects are not statistically significant. As a consequence, it is difficult to determine if regulated breathing had any effect on this study. Regularly practised controlled, slow, and deep breathing improves ANS control of HR.

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