ABSTRACT

The very effective and popular tool for measuring cardiac status and inter beat intervals is the Electrocardiograph (ECG). Electrocardiograph is a measure of bioelectric potential generated by contraction and relaxation of heart and is measured by placing the conductive devices over the chest by making one of the limbs as reference. ECG can also be extracted using simple three lead electrodes and can also have short time measurement studies which are sufficient for HRV analysis.

The Status of Autonomous Nervous System can be examined using Heart Rate Variability which can be extracted using ECG /PPG signal. Heart Rate Variability reflects the adaptability of the heart to the changing conditions by detecting and providing quick response to the random stimulus. The complete cardiac health and the condition of the Autonomic Nervous System which regulates the heart function can be analyzed using Heart Rate Variability.

Addictions and also stress are the major causes of morbidity and mortality across the world and that too among young population. The commonly used and easily available addictions being tobacco and alcohol are the root cause of social and health problems and at the same time stress induced diseases such as Hypertension, Diabetes Mellitus are also equal contributors of early death across the world. Hence the topic is socially and medically relevant.

These addictives and stress has an effect on ANS. Hence attempts have been made to analyze the behavior of ANS by analyzing HRV data. To achieve this, HRV data is studied among young population which is recorded by ECG and PPG signals obtained from individuals under the age group of 17-23 and also among pre-diabetic, hypertensive, stressed and compared with healthy individuals. HRV parameters so extracted are analyzed using Kubios Software.

As per literature review different methods are used to analyze Heart rate variability, such as Time domain methods, Frequency domain and nonlinear methods. Time domain measurement determines the time intervals between successive normal complexes. Geometrical measures are obtained by the study of intervals of the graph that denotes N to N interval and it is a histogram. The concentration of Sample represented as
D is built and it denotes the equally large number of N to N duration and correlates with the length of the graph.

Frequency Domain Analysis used for frequency measures on the ECG data and frequency measures involves the spectral analysis of HRV.

A nonlinear deterministic method is more appropriate in explaining more complicated phenomena. The cardiovascular system is very complex to be of a linear nature, the only way to understand the HRV is by using nonlinear methodologies. The results obtained are summarized as follows;

I. Alcoholics

HRV parameters were significantly lower in the alcoholic’s subjects. We can see that the scaling exponent for normal subjects is around one and for alcoholic’s subjects, it is away from one. Power law correlation in signal fluctuation and opposite heart condition of the two types of subjects under study i.e. normal and alcoholic’s subjects, is reflected clearly from the scaling exponent value.

By Detrended Fluctuation technique, we can easily differentiate between normal and alcoholic personnel. It is seen that normal subjects have higher ApEn value and alcoholic’s subjects have lower ApEn, thus clearly distinguishing the two groups. Disorder in the Heart rate signal and opposite heart condition of the two types of subjects under study is normal. Among alcoholics the abnormality is reflected clearly from ApEn value. Approximate Entropy is another method which easily differentiates between normal and alcoholic subjects. SD1 and SD2 are lesser in normal subjects comparatively to the alcoholic subjects. The Poincare plot can also be visually analyzed and the point under the ellipse shows the significant changes between the normal and alcoholic subjects. Linear methods such as mean of R-R interval at various time intervals were analyzed which indicates increased sympathetic tone, and decreased parasympathetic tone, the percentage on NN50 is around 36% in nonalcoholic’s and in alcoholics it is around 8 %. In this work, two kinds of data were analyzed which are obtained from subjects in the age group of 17 to 23. The parameters of linear methods and four nonlinear methods, sample entropy (ApEn), Shannon entropy and Recurrence plot analysis, Detrended Fluctuation Analysis have been applied to analyze HRV among 158 subjects of which 79 are control study (non-alcoholics) and 79 are alcoholics. The
analysis shows the effects of sympathetic and parasympathetic effects of Nervous system on the heart for alcoholic and non-alcoholic subjects, which are inferred by the linear and nonlinear parameters of HRV. Detrended Fluctuation analysis using MATLAB clearly differentiates between the alcoholic and non-alcoholic by studying the points along the line of the plot. In non-alcoholic subjects the points are aligned along the line of the plot, whereas in alcoholic subjects very few points are aligned along the line of plot. The low frequency power lies around 624ms$^2$ in non-alcoholic and around 1103ms$^2$ in alcoholic subjects. The Shannon Entropy values are around 2.5 in nonalcoholic’s and for alcoholic subjects it is around three. The above value clearly distinguishes the two data sets under study among alcoholics and non-alcoholics. The beat variability is considerably lower in the alcoholic’s subjects. The resultant Sample entropy values indicates that its values are near two in nonalcoholic subjects and in alcoholic subjects it is close to 1.5. So, by using Sample Entropy, we can easily separate the non-alcoholic and alcoholic personnel.

II. Smokers

The results obtained clearly shows decrease in HRV in smoking individuals declined than nonsmokers. The values of time domain and frequency domain are higher in smoking individuals compared to the nonsmoking individual.

We can see that the triangular index values of nonsmoking subjects are around 5.750 and for smoking subjects it is around 3.077. Power law correlation in signal fluctuation and opposite heart condition of the two types of subjects under study, i.e. nonsmoking and smoking subjects, is reflected clearly from the RR Triangular index value. So, by RR Triangular index we can easily differentiate between nonsmoking and smoking personnel.

Nonsmoking subjects have higher TINN value and smoking subjects have lower TINN, thus clearly distinguishing the two groups. Disorder in the Heart-rate signal and opposite heart condition of the two types of subjects under study, i.e. nonsmoking and smoking is reflected clearly from TINN value. So, by TINN Method, we can easily differentiate between nonsmoking and smoking subjects.

The values of SD1 and SD2 are lesser in nonsmoking subjects comparatively to the smoking subjects. The Poincare plot can also be visually analyzed and the points under the ellipse show the significant changes between the nonsmoking and smoking subjects.
Fatigued and normal individuals were analyzed and correlated with the standard index values, and grouped the individuals accordingly to normal and fatigued individuals.

**III. Stress and its affected diseases**

The HRV readings obtained from PPG analysis shows the different methods such as Time domain, Frequency domain and Non-linear methods were found to be low. The readings were found to be less compared to the normal subjects when studied N, SDNN, RMSDD, SD1 and SD2, the values were around 66.4, 55.7, 28, 36.7, and 83.5 respectively for stressed individuals.

The same trend of reduction of HRV values shows the impact of the diseases affecting ANS such as diabetics and hypertensives. The above parameters were analyzed which showed among diabetics 37, 88, 29, 78, 75 and 74 which on comparison which non-diabetics is too low and hence affecting ANS. The $\alpha$ values of Detrended Fluctuation Analysis was found to be greater than ‘1’ in diabetic subjects and in non-diabetic subjects $\alpha$ values was found to be less than ‘1’. The approximate Entropy was found to be lesser in hyper tensioned subjects compared to the normal subjects. The $\alpha$ values were found to be higher in hypertensive subjects compared to the normal subjects.