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Vital Analysis of Obese & Overweight Adults: HRV changes

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Conflict of Interest: Nill

Abstract

Background:

Many factors have been suggested as causes for this relationship, such as insulin resistance, hypertension, and reduced high-density lipoprotein. However, it has also been suggested that a reduction in autonomic function might be the mechanism for the increased prevalence of CVD in obesity. Recent studies have concentrated on the autonomic activity of the heart itself reported controversial findings. The autonomic nervous system is a control system that acts largely unconsciously and regulates bodily functions such as the heart rate, digestion, respiratory rate, papillary response, urination, and sexual arousal through its two branches: the sympathetic and parasympathetic nervous systems. Heart rate variability (HRV) measures the effect of autonomic function on the heart alone. Even a slight variation in autonomic regulation of the heart changes the heart rate and rhythm. The HRV looks through beat-to-beat variation during electrocardiogram (ECG) recording. Therefore, it could be the most useful and the simplest noninvasive method to investigate the effect of obesity on CVD. It is important to emphasize the effect of obesity on HRV, as decreased HRV significantly increases cardiovascular mortality. Because the autonomic nervous system controls a significant part of the internal functions of the body, fat disequilibrium in obesity is an important negative factor. The techogram shows HRV variability in figure 1. The risk of diseases appears to increase as a function of the percent fat content above an upper limit of normal in the body.

Discussion:

We recorded the HRV variables in subjects in resting state in order to avoid the fluctuation caused in RR intervals of ECG recording by any external stimulus to ensure that all changes that were observed in HRV in obese people were merely due to obesity. Reports by Thorp and Schlaich, Laederach-Hofmann et al, and Esler et al are in favor of our findings and they mentioned that obese persons suffer from an increased mortality risk supposedly due to cardiovascular disorders related to either continuously lowered parasympathetic or heightened sympathetic activation. Studies have also documented reduced HRV among overweight and obese individuals. In a study of 10 women with early-onset familial obesity and 10 nonobese women, several indices of HRV were reduced in the obese women. Karason et al, studied 28 obese patients referred for gastroplasty, 24 obese patients using a lifestyle dietary modification approach, and 28 nonobese persons.

Conclusion:

HRV has gained importance today as a technique to explore the ANS, which has an important role in maintaining homeostasis. Its use is diverse and it stands as mentioned above, as a predictor of the internal functions of the body, both in normal and pathological conditions. All three markers of non-linearity have risen in overweight youth, suggesting that future RR interval succession would be less predictable. Higuchi's and Katz's suggested fractal dimensions were used to differentiate between the two classes. Higuchi and Katz conducted the research that led to this realization. We used a kmax of 30 and a total of 1000 data points to get the best possible Higuchi fractal dimension. The 2019 novel coronavirus (2019-nCoV) outbreak is a major challenge for clinicians, and social, economic & public health prosperity to almost whole world. In india the economic progress and prosperity sturdily challenged and affected. The clinical course of patients remains to be

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fully characterized, little data are available that describe the disease pathogenesis, and no pharmacological therapies of proven efficacy yet exist.

Keywords: ANS, ECG, Variables, Heart, Obese, Overweight, Cardiovascular.

Introduction:

Obesity is a disorder of energy balance affecting wide range of people belonging to diverse ethnic groups, age and socioeconomic status. Prevalence of overweight and obesity is increasing in children and adolescents in India as reflected in various studies. Obesity becomes global burden and it is a significant contributor to morbidity and mortality**.** Nutritional problem in India is gradually shifting from undernourishment to obesity. It is a condition, which has evolved with the advent of civilization, sedentary life style and high calorie diet. Many factors have been suggested as causes for this relationship, such as insulin resistance, hypertension, and reduced high-density lipoprotein. However, it has also been suggested that a reduction in autonomic function might be the mechanism for the increased prevalence of CVD in obesity [1].

Recent studies have concentrated on the autonomic activity of the heart itself reported controversial findings. The autonomic nervous system is a control system that acts largely unconsciously and regulates bodily functions such as the heart rate, digestion, respiratory rate, papillary response, urination, and sexual arousal through its two branches: the sympathetic and parasympathetic nervous systems [2] Heart rate variability (HRV) measures the effect of autonomic function on the heart alone. Even a slight variation in autonomic regulation of the heart changes the heart rate and rhythm. The HRV looks through beat-to-beat variation during electrocardiogram (ECG) recording. Therefore, it could be the most useful and the simplest noninvasive method to investigate the effect of obesity on CVD [3]. It is important to emphasize the effect of obesity on HRV, as decreased HRV significantly increases cardiovascular mortality. Because the autonomic nervous system controls a significant part of the internal functions of the body, fat disequilibrium in obesity is an important negative factor. The techogram shows HRV variability in figure 1. The risk of diseases appears to increase as a function of the percent fat content above an upper limit of normal in the body [4].

These methods, which favor the Welch or Multi-Taper Method (MTM) power spectra, unfortunately discard phase information. As a result, we need to assess these statistics on teenage obesity with more precision. The settings were SGRRIM & HS Patel Nagar 500 samples were selected, and samples of obese adults over 100 kg (BMI > 28) were included. Purposive sampling was used. The techniques used for collecting the data were Shannon entropy, Renyi entropy, Tsallis entropy, and Higuchi fractal dimension. Patients with "dynamical illnesses," such as epilepsy, COPD, diabetes mellitus, and others, may be requested to participate in the procedure alongside healthy volunteers in order to discover ANS-related events. Prior work using chaotic global examined datasets of overweight children and adolescents.

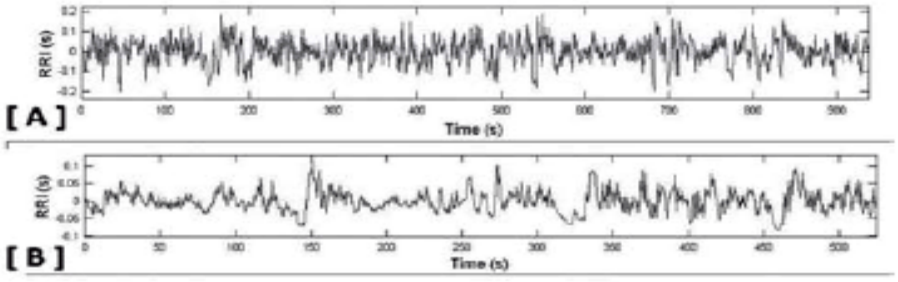

Fig. 1 - Tachogram of a normal young adult (A) and a normal newborn (B). The heart rate variability in panel B is much smaller than in panel A.

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Monitoring of trends in the prevalence of overweight and obesity depends on household surveys. Many health interview surveys include questions on self-reported weight and height that have been used to monitor trends overtime; [5] however, estimates of BMI from self-reported data have been shown to be biased downwards. Examination surveys provide direct measurements of weight and height but many fewer countries conduct repeated national examination surveys, and estimates from them may be biased because of low participation rates [6]. Despite the lack of complete and unbiased information on overweight and obesity, various systematic analyses have tried to capture levels and trends. Finucane et al. used data from 369 national surveys and 591 sub-national surveys to estimate country trends in mean BMI between 1980 and 2008. De Onis et al. [7], examined 450 national surveys to estimate trends in childhood obesity and overweight from 1990 to 2020. Mean BMI estimates have been used to predict levels of overweight and obesity over the period 1980-2008. These analyses suggest widespread increases in overweight and obesity have been occurring over the past few decades although recent country-specific analyses suggest that trends may have stabilized in some populations. [8].

Materials & Methodology:

The study was done at SGRRIMHS Patel Nagar. The sample size was 500 and the selected samples was obese adults about 100 kg (BMI > 28). The Purposive sampling was done and used according to all standards. The inclusion samples was taken as per standards rest all other unuseful samples was ignored which does not fulfilled the need of criteria.

HRV Analysis: Raw data for HRV analysis was obtained from a 'Lab Chart Recording' of heart beat signal. HRV parameters were noted and compared in different groups. Low frequency power(LF)- It is determined by both sympathetic and parasympathetic activity and provides an index not of cardiac sympathetic tone but of baroreflex function. High frequency power (HF)-Reflects mainly respiratory sinus arrhythmia as an index of cardiac vagal control. LF/HF ratio- may reflect a cardiac Sympathovagal balance. Statistical Analysis: All the data were expressed as mean ± SD. Statistical analysis of data was done by students 't' test (unpaired) and pearson correlation using microsoft excel. $p \geq 0.05$ - non significant, $*p \leq 0.05$- significant, $**p \leq 0.01$-highly significant, $***p \leq 0.001$-very highly significant. The techniques used for collecting the data were Shannon entropy, Renyi entropy, Tsallis entropy, and Higuchi fractal dimension.

Discussion

The HRV variables SDNN, RMSSD, NN50 count, pNN50, HF indices in milliseconds squared, and SD1, which reflect the cardiac parasympathetic nerve activity, were lower in obese persons than in normal weight persons. Moreover, as expected, the sympathetic marker LF/HF ratio [9] was increased in obese subjects in comparison to normal weight controls. It has been reported that obese persons have different HRV in response to some external stimuli [10]. We recorded the HRV variables in subjects in resting state in order to avoid the fluctuation caused in RR intervals of ECG recording by any external stimulus to ensure that all changes that were observed in HRV in obese people were merely due to obesity.

Reports by Thorp and Schlaich, Laederach-Hofmann et al, and Esler et al [11-13] are in favor of our findings and they mentioned that obese persons suffer from an increased mortality risk supposedly due to cardiovascular disorders related to either continuously lowered parasympathetic or heightened sympathetic activation. Studies have also documented reduced HRV among overweight and obese individuals. In a study of 10 women with early-onset familial obesity and 10 nonobese women, several indices of HRV were reduced in the obese women [14]. Karason et al [15], studied 28 obese patients referred for gastroplasty, 24 obese patients using a lifestyle dietary modification approach, and 28 nonobese persons. At baseline, both obese groups had reduced HF values relative to the nonobese participants. After 1 year of follow-up, those persons who had undergone gastroplasty had an average weight loss of 28% and showed evidence of increased vagal function as indicated by increased HF power. Also, several studies of obesity in children and adolescents have also found that vagal function is

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reduced in obese individuals compared to nonobese individuals [16-18]. In all of these studies, several indices of vagal function, such as HF power, were reduced in the obese individuals.

Table 1. Studies using comparatively the HRV in heart diseases.

Authors	Year	Disease	Assessed indexes	Conclusions
Reis et al. [64]	1998	AMI	Review Aticle	The positive predictive power of noninvasive methods is usually low, supporting the use of other resources in the stratification of post-AMI
Carnethon et al. [56]	2002	CAD	SDNN, HF	HRV can be used to identify differences in cardiac autonomic balance in healthy adults
Novais et al. [29]	2004	AH	RMSSD, VLF, LF, HF	No differences at rest between healthy and active individuals with AMI and AH
Menezes et al. [60]	2004	AH	SDNN, RMSSD, pNN50, HF, LF, LF/HF	HRV is decreased in hypertensive patients when compared to normotensive ones
Terathongkum et al. [61]	2004	AH	Review Article	Decreased HRV is an independent predictor of arterial hypertension in the patients
Takahashi et al. [55]	2005	CAD	RMSSD	There were no significant differences in HRV indexes in healthy sedentary and active coronary artery disease men
Bittencourt et al. [26]	2005	HC	RMSSD, pNN50, HF	There was a significant increase in parasympathetic modulation during controlled breathing associated with the tilt test in the patients
Pecyna [63]	2006	AMI	Indexes in time and frequency domain	HRV is decreased in post-AMI patients
Carney et al. [54]	2007	CAD	HF, LF, VLF	Moderate correlation was found between inflammatory factors and HRV in depressed coronary artery disease patients
Limongelli et al. [58]	2007	HC	SDNN, pNN50, RMSSD, LF, HF, LF/HF	The main clinical implication is the predictive value of HRV in risk stratification of children and young patients with HC
Karas et al. [59]	2008	AH	LF,HF,LF/HF	There was a reduction of hemodynamic responses (SAP and DAP) and sympathetic (LF) of elderly hypertensive
Larosa et al. [62]	2008	AMI	SDNN, frequency domain	HRV is decreased in patients with AMI

AMI: Acute myocardial infarction; CAD: Coronary artery disease; AH: Arterial hypertension; HC: Hypertrophic cardiomyopathy; HRV: Heart rate variability; SAP: Systolic arterial pressure; DAP: Diastolic arterial pressure

Currently, the HRV indexes have been used to understand various conditions, such as coronary artery disease, cardiomyopathy, arterial hypertension, myocardial infarction, sudden death, chronic obstructive pulmonary disease, renal failure, heart failure, diabetes, stroke, Alzheimer's disease, leukemia, obstructive sleep apnea, epilepsy, headache, among others. In diseases such as hypertension, acute myocardial infarction, coronary artery disease and atherosclerosis, HRV indexes are reduced. Menezes Jr et al.found reduced HRV in hypertensive compared to normotensive patients, when analyzing the SDNN, RMSSD, pNN50, HF, LF, LF/HF, probably due to a sympathetic hyperactivity. Decreased post-AMI HRV was also reported by several studies, as presented by Pecyna in a review article [19].

A reduced HRV has been identified as a strong indicator of risk related to adverse events in healthy individuals and patients with a large number of diseases, reflecting the vital role that ANS plays in maintaining health. In hypertrophic cardiomyopathy, it is assumed that the neuronal uptake of norepinephrine is impaired due to a decrease in the density of beta receptors. Studies using HRV indexes in cardiovascular diseases can be seen in the assessment of HRV has also been widely used in order to diagnose both physiological and psychological disorders [20]. In sports medicine, for example, is generally used to assess adaptations related to resistance training and exercise. The regular practice of physical activity has been reported as a factor in increased vagal tone due to physiological adaptations that have occurred by the increase in cardiac work, since there is a decreased sensitivity of beta receptors [21]. Thus, the increase in parasympathetic modulation induces an

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electrical stability of the heart, while the high sympathetic activity increases the vulnerability of the heart and the risk of cardiovascular events [22].

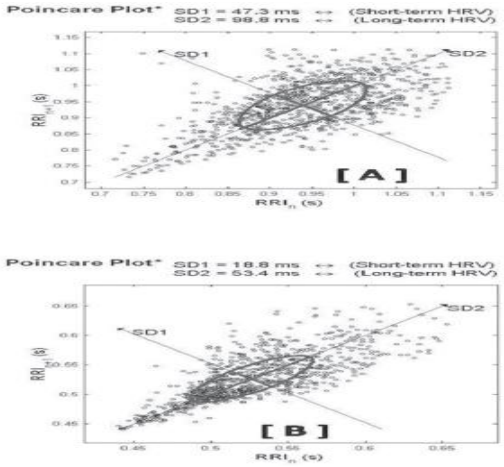

Fig. 2 — Poincaré chart of a normal young adult (A) and a normal newborn (B). The dispersion of both short- (SD1) and long-term in panel B (SD2) is smaller than in panel A

Novais et al. assessing the RMSSD, VLF, LF, HF, found no significant differences at rest between healthy sedentary men and active patients with AH and AMI, suggesting the effect of physical activity on autonomic modulation of these patients [23]. This effect has also been proposed by Takahashi et al. [24], when analyzing the RMSSD index at rest in active coronary artery disease patients and healthy individuals, in which significant differences were also not found.

Results

The effect size, also known as the degree to which the various treatments differed from one another, was determined with the help of Cohen's d. A value of 0.9 or higher was deemed to have a big impact size; a value of 0.5 to 0.75 was considered to have a medium effect size; and a value of 0.25 to 0.8 was considered to have a moderate effect size. There is a significant amount of difference in the outcomes that occur for both the children who are not obese and the children who are overweight. Given the insignificance of the findings obtained using approximate entropy, sample entropy, and DFA, it is not warranted to continue discussing these metrics in any further detail.

There is a possibility that statistical analysis of Shannon entropy, Renyi entropy, and Tsallis entropy will lead to the discovery of significant findings. In each of these three scenarios, the level of disorder gets worse. After that, we determined the maximum k values at which the HFD was most apparent and calculated those values.

As a measure of central tendency, the mean is used because, in parametric statistics, it is assumed that the relevant datasets have a normal distribution. As a result, the mean is utilized. Because we are unable to normalise the data, we are unable to make meaningful comparisons of means. We used the Anderson-Darling and Ryan-Joiner procedures to determine whether or not the data was normal. Due to the lack of clarity provided by these results, it is not possible to state with absolute certainty whether or not the data follow a normal or nonnormal distribution.

Because of this, when determining the statistical significance of our findings, we employed both parametric and non-parametric tests. In particular, we make use of ANOVA as well as the Kruskal-Wallis test. On Cohen's d, the effect size was deemed to be medium for all kmax values between 11 and 60, and the p value was less than 0.05. Nevertheless, in order to derive the greatest benefit from the algorithm, kmax needs to be adjusted to a value of 20. Concurrently with this change, the proportion of children who did not meet the criteria for either overweight or obesity dropped. It was believed that this was the maximum possible capacity. In order to conduct the HFD study, a minimum of 1,000 RR intervals were required from each group. However, unlike HFD, Katz's approach benefits from a longer time series. Therefore, a cubic spline interpolation was imposed on the range that went from 1 Hz to 15 Hz. On the other hand, Katz's technique exhibited the maximum degree

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of significance, which indicated a reduction in mean values from normal non-obesity to juvenile obesity. As the length of the time series goes up and the frequency of the cubic spline interpolation goes up to more than 2 Hz, the significant values for all three statistical tests go down steadily [24].

Conclusion

HRV has gained importance today as a technique to explore the ANS, which has an important role in maintaining homeostasis. Its use is diverse and it stands as mentioned above, as a predictor of the internal functions of the body, both in normal and pathological conditions. All three markers of non-linearity have risen in overweight youth, suggesting that future RR interval succession would be less predictable. Higuchi's and Katz's suggested fractal dimensions were used to differentiate between the two classes. Higuchi and Katz conducted the research that led to this realization. We used a kmax of 30 and a total of 1000 data points to get the best possible Higuchi fractal dimension. Because of this, we were able to get the most reliable data. To me, this makes no logical sense at all. I don't have first-hand knowledge to provide. Due to this, the chaotic global entropy or one of the other three entropies mentioned earlier must be necessary in order to serve as a statistical marker for obesity.

The widest possible use, the cost-effectiveness in the application of the technique and ease of data acquisition makes the HRV an interesting option for interpretation of the functioning of the ANS and a promising clinical tool to assess and identify impairments on health.To achieve optimum group separation using Katz's fractal dimension, we needed a 2Hz cubic spline interpolation, which required the collection of 500 samples. We were able to realize our objective because of this. By using these fractal dimension tactics, typically developing children and adolescents showed a more orderly reaction than their fat counterparts.

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