ISSN: 2581 – 3633
PubMed - National Library of Medicine - ID: 101745081

International Journal of Medical Science and Advanced Clinical Research (IJMACR)

Available Online at:www.ijmacr.com

Volume – 6, Issue – 3, May - 2023, Page No. : 01 - 06

A Prospective Study of Heart Rate Variability in Young Populations Who Are Under and Overweight

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How to citation this article: Arohi Abhinav Jayaswal, Roma Yadava, "A Prospective Study of Heart Rate Variability in Young Populations Who Are Under and Overweight", IJMACR- May - 2023, Volume – 6, Issue - 3, P. No. 01 – 06.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Objective: Obesity is a condition marked by an excess of adipose tissue mass, and it is typically measured using the Body Mass Index (BMI). The autonomic nervous system is crucial in controlling how much energy is expended and how much body fat is present. One test used to gauge how the heart is affected by autonomic regulation is heart rate variability (HRV). The aim of the study was to identify specific HRV-related features in two groups of 18 to 25-year-olds who were overweight (OW) and underweight (UW) to better understand how young people's HRV varies because of their body weight.

Method: This prospective study was carried out at Jawaharlal Nehru Medical College, Bhagalpur within one year. Measurements of anthropometry, resting heart rate, blood pressure, and 4-minute supine HRV are taken. A correlation study and unpaired t-test are used to compare the effects of body weight on the HRV spectrum between two groups.

Results: According to this study, the overweight group had significantly lower low frequency normalized units (LFnu) than the underweight group did, as well as significantly lower total power (TP), high frequency (HF), SDNN (Standard deviation of NN interval), and RMSSD (Square root of Mean Squared Differences of Successive NN Interval). Between these groups, there was a very strong negative association between Resting Pulse (RP), LFnu, and HFnu.

Conclusion: These data show an autonomic dysfunction in the overweight group of students that is characterized by a decrease in parasympathetic activity and an increase in sympathetic activity, which may cause an early cardiac condition.

Keywords: Overweight, Underweight, Total Power, High Frequency, Autonomic Dysfunction.

Introduction

Body mass index (BMI) derangement results in a dual consequence, either obesity from overeating or malnutrition from insufficient consumption. A condition of excessive adipose tissue mass is referred to as obesity [1]. The rate of increase in overweight and obesity has increased to worrying levels [Figure 1; 1]. It is currently a significant health issue in emerging nations, particularly India [2]. In affluent countries, it is estimated that between 20 and 40 percent of adults and between 10 and 20 percent of children and adolescents are overweight [2]. While 7.3 percent of men in rural India and 22.2 percent of men in urban India are obese, 8.6 percent of women in rural India and 28.9 percent of women in urban India are overweight [3].

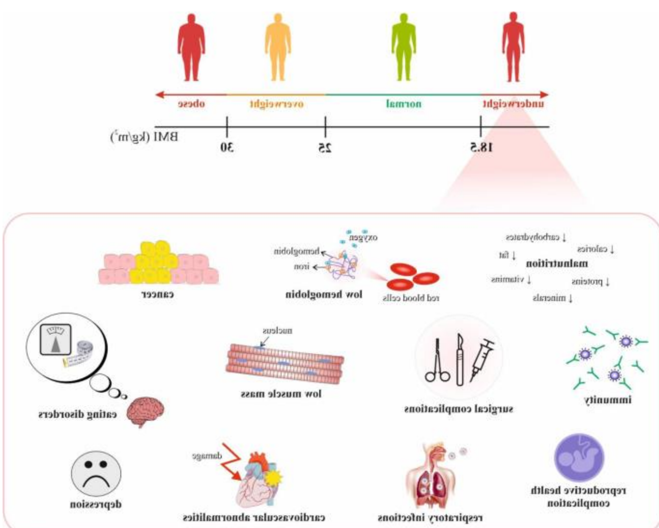

Figure 1: Health risks associated with Obesity

Numerous variables, including insulin resistance, hypertension, and decreased high density lipoprotein, are linked to the development of obesity [5]. On the other hand, it has also been hypothesised that a decline in autonomic function may be the cause of obesity's increased risk for cardiovascular disease, as this system is crucial for controlling both body fat percentage and energy expenditure [5]. The only influence of autonomic function on the heart is measured by heart rate variability. As a result, it might be the best approach to utilise for examining how obesity affects cardiovascular disease [6]. On the other hand, malnutrition is a long-standing issue for many Indians. Numerous students in our nation attend schools and colleges while undernourished. Based on a base mass index (BMI; kg/m^2) of less than 18.5 it is thought that 50% of adults are undernourished [6]. They also exhibit a deficit in height, which may be a sign of stunting from inadequate dietary intake throughout childhood.

To assess the relationship between BMI and Heart Rate Variability in overweight and underweight young adults, the current study was conducted with this objective in mind.

Methods

Study Design: This prospective study was carried out at Jawaharlal Nehru Medical College, Bhagalpur within one year.

Methodology: All the individuals' medical histories were recorded prior to the trial, and they were given 4 minutes to rest before the test started. By requesting the individuals to stand on a height-measuring stand and having their height measured in meters, the body mass index (BMI) of the subjects was determined. Following that, weight was determined using a scale and recorded in kilograms. BMI is computed using the kg/m^2 unit.

Each subject was given a 4-minute break before having their HRV measured while comfortably supine on their beds. Continuous ECG tracing was taken for 5 minutes using the RMS Polyrite D instrument to obtain Time Domain analysis by SDNN (Standard Deviation of Two Successive NN interval) and RMSSD (Square root of Mean Squared Differences of Successive NN interval) as well as Frequency domain (Spectral) analysis by Total

Power (TP), High Frequency (HF), High Frequency normalised unit (HFnu), Low Frequency (LF), and LF/HF.

Sample Size: A total of 120 patients were enrolled in this study, however, only 100 participants met the inclusion criteria.

Inclusion criteria: Participants from age 18-25, BMI >24 kg/m^2, BMI <17 kg/m^2 were included in the study.

Exclusion criteria: The study excludes participants who have a history of hypertension or other systemic disorders.

Statistical analysis: Data were statistically analyzed using SPSS software. Mean ± SD was used to express the data. With an unpaired t-test, the level of significance between the two groups was assessed. Values that differed significantly between the two groups were approved with a p-value of less than <0.04. Correlation research was conducted to find the link between the HRV data of the underweight group and the overweight group.

Results

Table 1 displays the distribution and comparability of the study individuals' data. The data is shown as Mean ± SD.

Table 1: Age, BMI, and baseline cardiovascular parameters averages between the overweight and underweight groups. (N=100)

Parameters	Over-weight (OW) Mean ± SD	Under-weight (UW)Mean ± SD	OW vs UW P-values
Age (Years)	20.7± 0.96	18.4± 0.67	0.06
BMI (kg/m^2)	27.3± 1.03	18.0 ± 0.56	0.031
Pulse (BPM)	87.51± 3.0	71.44 ± 3.50	0.0071
Systolic BP(mm of Hg)	117.8 ± 8.8	113.2 ± 6.0	0.031
Diastolic BP(mm of Hg)	79.1 ± 4.70	79.8 ± 4.23	0.42

According to the data, the overweight and underweight groups' BMI, resting pulse, and resting systolic blood pressure are significantly different.

Table 2 shows that there are statistically significant differences in HF and Total Power (TP) between the overweight and underweight groups, with a P-value of less than 0.02 being recognised as statistically highly significant.

Table 2: Average HRV parameter values for the research subjects

Parameters	Over weight (OW) Mean± SD	Under weight (UW) Mean± SD	OW vs UW: P-values
Sup-TP (ms2)	1292.2± 177.7	1907.5± 366.1	0.0031
Sup-LF (ms2)	798.0± 63.7	813.8± 58.8	0.194
Sup-HF (ms2)	516.2± 171.8	1069.2± 345.5	0.00024

The data in **Table 3** show that there are statistically significant differences in Sup LFnu, LF/HF ratio, SDNN, and RMSSD between the overweight and underweight groups, as well as extremely significant statistical differences in Sup HFnu.

Table 3: Average values of the HRV parameters (LFnu, HFnu, LF/HF, SDNN, and RMSSD) in the Supine (Sup) position were compared between the Overweight and Underweight groups.

Parameters	Overweight (OW)Mean ± SD	Underweight (UW)Mean ± SD	OW vs UW: P-values
Sup-LFnu	57.64± 14.4	44.0± 10.4	0.0018
Sup-HFnu	39.2± 7.2	56.92±10.52	0.0008
Sup LF/HF	1.36± 0.30	0.97± 0.23	0.020
Sup- SDNN	45.8± 5.45	63.1± 2.15	0.035
Sup-RMSSD	50.56± 7.30	74.13± 2.42	0.025

On RP, Sup-LFnu, and Sup-HFnu, there is a substantial negative connection between underweight and overweight patients. Only between the two groups of study subjects did Sup-LF and Sup-HF exhibit a negative association, whilst other measures indicate a positive but negligible relationship.

Discussion

This population-based study demonstrates how the HRV spectrum changes in relation to BMI. The evaluation of parameters related to HRV in the current study also reveals a substantial reduction in Total Power (TP), High Frequency (HF), SDNN, and RMSSD, as well as a higher Low-Frequency Normalized Unit (LFnu), in the overweight group compared to the underweight group, suggesting a cardiovascular autonomic imbalance that is characterized by increased sympathetic activity in the overweight group.

In this study, tachycardia caused a statistically significant rise in RP for the overweight group compared to the underweight group, which resulted in a statistically significant drop in TP and SDNN, suggesting higher sympathetic activity in the overweight group. The TP and SDNN, which are opposites of one another, both show global variability and sympathetic activity, which is characterised by a notable decrease in both of them in tachycardia, which may be related to a reduction in the variability of sympathetic activity. Similar findings were observed in a study that used obese children and non-obese children as the study group and control group, respectively [7].

As demonstrated in clinical and experimental studies of autonomic maneuvers such electrical vagal stimulation, muscarinic receptor blockade, and vagotomy, the efferent vagal activity is a significant contributor to the HF component in spectral analysis and RMSSD in temporal domain analysis. In this study, it was discovered that the RMSSD, HF, and HFnu were statistically significantly lower in the overweight group than in the underweight group. Therefore, it can be inferred that the hallmark of the overweight population will be a decrease in parasympathetic activity. This result is in line with another research [8].

In comparison to the underweight group, the overweight group had statistically significant higher levels of resting sympathetic activity, as shown by an increase in LFnu, which some people regard as a sign of sympathetic modulation (especially when expressed in normalized units) and others as a parameter that includes both sympathetic and vagal influences when expressed as absolute power (ms^2 unit).

Young overweight subjects' LF/HF ratios are statistically higher than those of underweight participants, demonstrating sympatho-vagal balance, suggesting that obesity is linked to cardiovascular autonomic imbalance. Previous research found that all obese groups had considerably higher LF/HF and heart acceleration compared to normal and lean controls [10,11].

With r = -0.366, RP (UW) and RP (OW) showed a strong negative association, indicating that the RP values for the overweight group gradually increased relative to the underweight group. Lower parasympathetic activation is the cause of this. With r = -0.381 showing greater sympathetic activity in overweight patients, a significant negative association between Sup-LFnu (UW) and Sup-LFnu (OW) was found. Once more, a strong negative correlation between Sup-HFnu (UW) and Sup-HFnu (OW) was found, with a r value of 0.388 showing a decrease in Sup-Hfnu values for the overweight group, which may be caused by a reduction in parasympathetic activity. Numerous research projects carried out by numerous researchers produced similar conclusions [12-15].

It is clear from the explanation above that the main cause of the HF component is vagal activity. Furthermore, it is proposed that LF, when expressed in normalised units, might be used as a quantitative indicator of sympathetic modulations. Another study concluded that the LF was reflecting both sympathetic and vagal activity. As a result, several researchers believed that the LF/HF ratio reflected sympathetic modulations or mirrored sympathovagal balance [16]. It is still unknown what causes these modifications in parasympathetic nerve activity in overweight people.

Conclusion

By having enhanced LF (nu) and RP and depressed TP and SDNN, the current study amply shown that young overweight people have elevated resting sympathetic activity. Obesity is linked to a cardiovascular autonomic imbalance, as seen by a lower parasympathetic activity as shown by a decrease in HF (nu), HF, and RMSSD under OW individuals. The study suggested that for the overweight group of persons, HRV-associated features such as RP, Sup-LF, Sup-HFnu, and Sup-HF values should be frequently evaluated for early diagnosis of heart-related complications.

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