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EVALUATION OF CARDIAC AUTONOMIC CONTROL DURING SIX-MINUTE WALK TEST IN OBESE AMONG MEDICAL FACULTY STUDENTS OF UDAYANA UNIVERSITY

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ABSTRACT

Increased body mass index (BMI) has been associated with various chronic diseases and tends to increase from adolescence to young adulthood, potentially contributing to the development of cardiovascular disease later in life. However, studies directly linking BMI and cardiovascular risk factors, particularly in adolescents and young adults, are limited. Early intervention is crucial to prevent serious consequences such as death from obesity. Functional capacity, which can be assessed through the Six Minute Walk Test (6MWT), is an important indicator in assessing the physical limitations of obese patients and guiding appropriate interventions. In this study, measurements were carefully taken in 75 participants (35 men and 40 women), with close monitoring of conditions before and after the 6MWT. One of the main focuses was Heart Rate Variability (HRV), which reflects the autonomic control of the heart. Results showed a significant relationship between BMI and HRV, where the higher the BMI, the lower the HRV (p=0.000), signaling the importance of early weight control to prevent cardiovascular autonomic dysfunction.

Keywords : obesity., autonomic heart control., 6MWT

INTRODUCTION

Under- and overnutrition in adults is an important problem today because it is a risk factor for cardiovascular diseases. The risk of developing metabolic and degenerative diseases with overweight is two to three times more likely than with normal or underweight. The increase in body weight is very influential on the mechanism of the onset of obesity in obese people but the mechanism of this occurrence is not yet clearly understood but it is suspected that in obese people there is an increase in plasma volume and cardiac output which will increase certain blood pressure. Obese patients need to be intervened early because delay can cause fatal things to death.[2]

Functional capacity is an objective assessment that can be done in patients with certain diseases. In obese patients, functional capacity is carried out to assess the ability to perform daily activities. As a reflection of functional capacity, the walking distance on the six-minute walk test can be used. Measurements are taken carefully and conditions before and after the six-minute walk test are scrutinized.

Heart Rate Variability (HRV) or RR interval is the time elapsed between two consecutive R waves (waves with the largest amplitude). HRV is closely related to the human autonomic nervous system. The autonomic nervous system itself is divided into two, namely the sympathetic nervous system and the parasympathetic nervous system. The sympathetic nervous system functions to increase the body's responses to perform strenuous activities or in the face of stressful situations. In activities like this, for example, the sympathetic nervous system will regulate the heart to beat faster and stronger.[3] The parasympathetic nervous system dominates in calm and relaxed activities or circumstances so that it will regulate the heart not to beat quickly and strongly. The purpose of this study was to examine and evaluate the autonomic control of the heart during the six-minute walk test in obese patients among students of the Medical Faculty of Udayana University.

METHODS

Observational analytic with a cross-sectional design was used to evaluate cardiac autonomic control, and purposive sampling was used as the sampling technique to achieve the study objectives.

Research strategy and sample criteria

This study was conducted on all obese patients among Medical Faculty of Udayana University students as the affordable population of this study. To find out that the affordable population can become eligible subjects in this analytical observational study, inclusion criteria are set, such as not being on leave from work at the time the entire research process is carried out (annual, marriage, childbirth, or illness), not being in training that leaves

his duties at the faculty, willing to become a respondent as evidenced by a letter of willingness to become a respondent, having a normal body mass index (18. 5-22.9 kg/m2), overweight (23-24.9 kg/m2), and obesity (>25 kg/m2), not being ill and or under a doctor's care related to coronary heart disease, diabetes mellitus, hypertension, kidney failure and other chronic diseases, and not taking anti-hyperlipid drugs.

The selection of samples that met the inclusion criteria was carried out by the research team directly (P.P.N., N.M.D.L., A.P.H.F., and K.Y.A.). The minimum sample size used in this study was 32 people. Before this study began, research permits, ethics, and informed consent were obtained to facilitate the continuity of the study. When the study began, the research team (P.P.N., N.M.D.L., A.P.H.F., and K.Y.A.) directly prepared several instruments to collect data ranging from questionnaires of demographic characteristics of respondents, tools for physical measurements before 6MWT, post 6MWT examination tools.

Before the six-minute walk test, the research team (P.P.N., N.M.D.L., A.P.H.F., and K.Y.A.) will prepare the respondents by asking each participant to wear comfortable clothes, not allowed to exercise heavily within 2 hours before the test, allowed to eat light food, if there is a foot problem, can use a walker, stay on medical treatment if they have a history of heart, lung and blood vessel disease, do not do a warm-up period before the test, and conduct a physical examination before the 6MWT. When the test started, the research team (P.P.N., N.M.D.L., A.P.H.F., and K.Y.A.) would supervise each participant and watch the time running on the stopwatch. After 6 minutes, the research team (P.P.N., N.M.D.L., A.P.H.F., and K.Y.A.) will conduct a post 6MWT examination on each participant, such as the level of dyspnea and fatigue using the Borg scale and measuring SpO2 and pulse rate. After all the research data is collected, the research team (P.P.N., N.M.D.L., A.P.H.F., and K.Y.A.) will directly analyze the data. Furthermore, the results of data analysis will be matched with previous research in a discussion session (G.N.P.J).

Outcome measurement

The primary outcomes of this analysis were demographic characteristics questionnaire for university students (consisting of age, gender, weight, height). The secondary outcomes included Physical and clinical measurements before the six-minute walk test (scale, meter, tensimeter, oximetry, walk timer, Polar H10 HRV device, ELITE HRV app). The tertiary outcomes included six-minute road test post-check (tensimeter, oximetry, road timer, HRV device Polar H10, ELITE HRV app).

Data analysis

Data analysis used univariate analysis for patient characteristics, presented as mean + standard deviation if numerical data, and categorical data in the form of number (percentage). Then the normality test is carried out depending on the number of samples. Bivariate test is a data analysis conducted to determine whether there is a relationship between the independent variable and the dependent variable that is meaningful or not. Pearson correlation test for normal data distribution or Spearman for abnormal data distribution. The results are said to be significant if the p value is <0.05. Numerical correlation test results that were interpreted included the strength of correlation based on the correlation coefficient (r), the direction of correlation, and the significance of the p value. Multivariate analysis to assess the association of mileage and HRV on the six-minute walk test after accounting for confounding variables. This was controlled by multiple linear regression test analysis or partial correlation. The results of multivariable analysis were presented with 95% confidence intervals (CI) and p values. All p values used a 2-way statistical test and p values <0.05 were considered statistically significant.

RESULT

The RR interval occurs during an increase in blood flow in the cardiac cycle and can be seen in the QRS signal. Each signal shows different information. Therefore, Heart Rate Variability is one way to determine the physiological differences of the heart calculated based on the time domain. The recorded data is in text format and processed using EliteHRV. **Figure 1, Figure 2, and Figure 3** is an example of the RR interval results on the research subject.

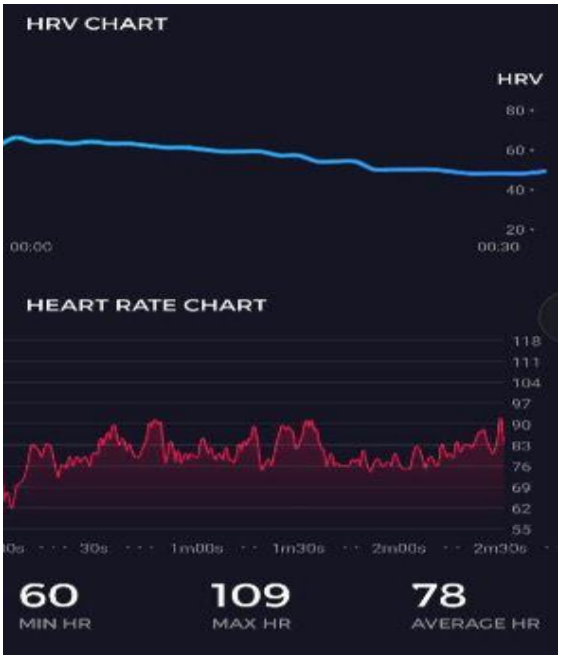

Figure 1. HRV recordings in normal weight study participants

There were 75 participants in the study, consisting of 35 men (46.7%) and 40 women (53.3%). Significant results were obtained in HRV. HRV data is the delta of the change in pulse rate variability at the beginning of the six-minute walk test with the end of the six-minute walk test. The results showed that the higher the body mass index, the lower the heart rate variability (p=0.000). The mean HRV was significantly different in the normal, overweight, and obese BMI groups (p<0.001), with a mean HRV of 46 ms (SD±16.74) in the normal group, 41 ms (SD±14.02) in the overweight group, and 24 ms (SD±3.59) in the obese group.

Figure 2. HRV recordings in overweight study participants

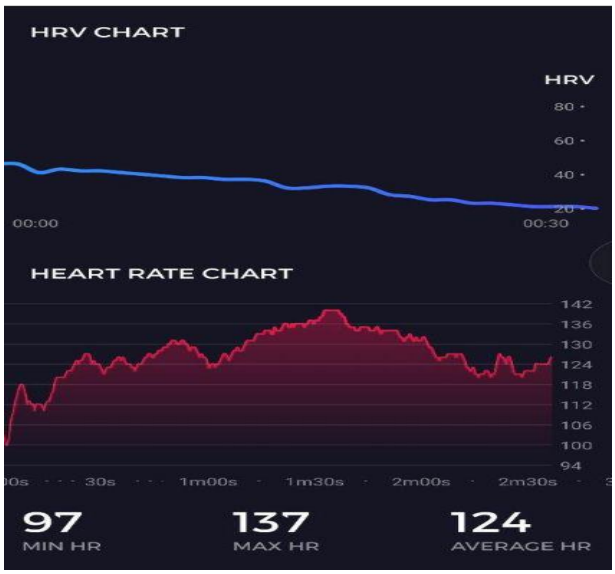

Figure 3. HRV recordings in obesity study participants

The median walking distance and LF power were also significantly different in the BMI category groups with p<0.001 for walking distance, and p=0.042 in LF power. The median road distance in the normal group was 420 meters (320 meters - 460 meters) with LF power 154 ms2 (11- 405), in the overweight group 400 meters (300 meters - 450 meters) with LF power 130 ms2 (11-364), and the median road distance in the obese group was 350 meters (250 meters - 400 meters) with median LF power 67 ms2 (11-476). Meanwhile, maximal HR, total power, LF peak, HF peak, HF power, and LF to HF ratio were not statistically significantly different in the IMT category groups.

Table 1. Characteristics of study participants

Karakteristik	Rata-rata	Standar Deviasi
Age (year)	21	0.00
Weight (kg)	65.6667	13.16048
Height (cm)	161.28	7.868
BMI (kg/cm2)	25.2198	4.57711
Road distance (meter)	373.6	51.033
HRV	37.9733	16.28212
MinHR	86.7733	17.19960
MaxHR	120.0533	14.62956
AverageHR	107.1333	15.46516
RMSSD	20.6920	18.68783
SNDD	32.1525	18.00935
LN	2.7461	.89129
MeanRRinterval	575.6017	85.66164

TotalPower	217.3259	222.59909
LFtoHFratio	4.4779	3.94079
LFpower	145.15	117.70
HFpower	59.13	84.68
LFpeak	1.3893	11.3064
HFpeak	0.2688 0.00	0.12123

Table 2. ANOVA Bivariat test results

Parameter	**IMT normal (n=25)**	**IMT berat badan berlebih (n=25)**	**BMI obesitas (n=25)**	***P value* (ANOVA)**
HRV (ms)	48.64+ 16.7	41.12+14.02	24.16+3.59	0.000
MinHR (bpm)	82.36+18.56	90.20+16.08	87.76+16.59	0.260
MaxHR (bpm)	119.76+14.87	118.64+14.52	121.76+14.90	0.752
AverageHR (bpm)	104.52+16.71	106.60+15.97	110.28+13.60	0.634
meanRRinterval (ms)	596.09+91.14	577.40+95.69	553.30+85.66	0.148
LFtoHFratio (%)	3.80+3.98	4.34+2.97	5.29+4.68	0.210

Table 3. Chi Square test

Komponen	***P value***
Road distance	0.000
RMSSD	0.312
SNDD	0.545
LFpower	0.042
HFpower	0.106
Lfpeak	0.166
Hfpeak	0.940
Total power	0.084

DISCUSSION

The results of this study showed a significant relationship between heart rate variability (HRV) and body mass index (BMI) in a university student population. Data obtained from 75 participants, consisting of 35 males (46.7%) and 40 females (53.3%), indicated that HRV decreased as BMI increased. The mean HRV in the normal BMI group reached 48.64 ms, while those in the overweight and obese groups were 41.12 ms and 24.16 ms, respectively, with a p value <0.001 indicating a statistically significant difference.

ANOVA analysis showed that changes in HRV were negatively correlated with increases in BMI. This is in line with previous studies stating that obese individuals tend to have lower cardiac autonomic control, which may contribute to future cardiovascular disease risk.[1] Decreased HRV can be interpreted as a sign of increased physiological stress and disturbances in autonomic nervous system function.[7]

The decrease in HRV in the obese group is consistent with previous findings linking obesity with increased sympathetic nerve activity and decreased parasympathetic activity, which may increase the risk of cardiovascular disorders.[1, 12, 16, 20] Low heart rate variability indicates reduced flexibility of the cardiovascular system in response to physiological needs, such as during physical activity or emotional stress.[7]

Furthermore, Chi-Square test results showed that the distance covered in the six-minute walk test was also significantly associated with BMI category (p = 0.000). The median walking distance in the obese group only reached 350 meters, compared to 420 meters in the normal BMI group. This reflects the limited physiological adaptation to increased oxygen demand during physical activity in obese individuals.[4] This suggests that individuals with higher BMI tend to have lower physical performance, which may have contributed to the decrease in HRV.[13, 14] This is in line with the findings of a research who indicated that physical activity can improve heart rate variability and overall cardiovascular health.[3]

In addition, the significant difference in low-frequency (LF) power values in HRV analysis strengthened the evidence of autonomic control dysfunction in the obese group. The median LF power in the obese group was lower compared to the normal group (67 ms² vs. 154 ms²; p=0.042). This decrease may reflect the dominance of sympathetic activity that is not balanced by parasympathetic activity.[3, 15, 18]

However, several other parameters such as total power, high-frequency (HF) power, and LF/HF ratio did not show significant differences between groups. This may be due to high individual variability or limited sample size in detecting more subtle differences.[8]

The results of this study are in line with previous findings emphasizing the importance of weight control as part of cardiovascular disease prevention efforts through improving cardiac autonomic regulation. Further research is needed to explore the biological mechanisms underlying the relationship between obesity and cardiac autonomic control dysfunction, as well as effective interventions to improve HRV in populations with high BMI.[10, 17, 19] Efforts to prevent and control risk factors must be carried out consistently to improve the quality of public health.

1. CONCLUSION AND RECOMMENDATION

This study demonstrated a significant association between body mass index (BMI) and cardiac autonomic control, as reflected by heart rate variability (HRV), among medical students. Obese participants showed markedly reduced HRV compared to their normal and overweight peers, indicating impaired autonomic function. Additionally, walking distance during the six-minute walk test decreased significantly with increasing BMI, reflecting reduced functional capacity. The lower low-frequency (LF) power among obese individuals further supports the presence of autonomic imbalance, likely characterized by heightened sympathetic and reduced parasympathetic activity. These findings underscore the potential of HRV as a non-invasive marker for early cardiovascular risk in young obese populations.[11]

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