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THE DEPENDENCE OF SPECTRAL CHARACTERISTICS OF HEART RATE VARIABILITY FROM BODY MASS INDEX IN CONDITIONALLY HEALTHY

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In 102 conditionally healthy volunteers aged from 19 to 30 years (average age is 19,53 ± 11 years) the volatility of heart rate variability (HRV) spectral parameters depending on body mass index (BMI) were evaluated. According to WHO recommendations on the calculation and interpretation of BMI were such groups of volunteers: underweight, normal body weight, overweight, obesity I degree, obesity II degree, obesity III degree. Among HRV parameters were evaluated total power (TP, ms^2), power of very low frequency (VLF, ms^2), low frequency (LF, ms^2) and high frequency (HF, ms^2) domains of HRV spectrum in the 5-minute intervals of ECG in I standard lead. The data were processed by methods of nonparametric statistics. It was established that spectral characteristics of HRV in volunteers with normal BMI have a high TP with harmonious relations between VLF, LF and HF domains; decreased or increased BMI provokes TP reduction by decreasing power of all domains of HRV (VLF, LF, HF) with a predominance of VLF proportion and this effect increases with the degree of deviation of the parameter.

KEY WORDS: heart rate variability, body mass index, conditionally healthy volunteers

ЗАЛЕЖНІСТЬ СПЕКТРАЛЬНИХ ХАРАКТЕРИСТИК ВАРІАБЕЛЬНОСТІ СЕРЦЕВОГО РИТМУ ВІД ІНДЕКСА МАСИ ТІЛА У УМОВНО ЗДОРОВИХ ДОБРОВОЛЬЦІВ

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У 102 умовно здорових добровольців у віці від 19 до 30 років (середній вік 19,53 ± 11 років) була оцінена мінливість спектральних параметрів варіабельності серцевого ритму (ВСР) в залежності від індексу маси тіла (ІМТ). Відповідно до рекомендацій ВОЗ щодо розрахунку та інтерпретації ІМТ були виділені такі групи добровольців: недостатня вага, нормальна вага, надмірна вага, ожиріння I ступеня, ожиріння II ступеня, ожиріння III ступеня. Серед показників ВСР оцінювали загальну потужність (TP, ms^2), потужність дуже низьких (VLF, ms^2), низьких частот (LF, ms^2) і високих (HF, ms^2) частот доменів спектру ВСР в 5-хвилинних інтервалах ЕКГ в I стандартному відведенні. Дані були оброблені методами непараметричної статистики. Встановлено, що спектральні характеристики варіабельності серцевого ритму у добровольців з нормальним ІМТ мають високу TP із гармонійним співвідношенням між доменами VLF, LF, HF; зниження або підвищення ІМТ провокує зниження TP за рахунок зменшення потужності всіх спектрів ВСР (VLF, LF, HF) з переважанням долі VLF і цей ефект зростає зі збільшенням ступеня відхилення параметра.

КЛЮЧОВІ СЛОВА: варіабельність серцевого ритму, індекс маси тіла, умовно здорові добровольці

ЗАВИСИМОСТЬ СПЕКТРАЛЬНЫЕ ХАРАКТЕРИСТИК ВАРИАБЕЛЬНОСТИ СЕРДЕЧНОГО РИТМА ОТ ИНДЕКСА МАССЫ ТЕЛА У УСЛОВНО ЗДОРОВЫХ ДОБРОВОЛЬЦЕВ

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У 102 условно здоровых добровольцев в возрасте от 19 до 30 лет (средний возраст 19,53 ± 11 лет) была оценена изменчивость спектральных параметров вариабельности сердечного ритма (ВСР) в зависимости от индекса массы тела (ИМТ). В соответствии с рекомендациями ВОЗ по расчету и интерпретации ИМТ были выделены следующие группы добровольцев: недостаточный вес, нормальный вес, избыточный вес, ожирение I степени, ожирение II степени, ожирение III степени.

Среди показателей ВСР оценивали общую мощность (TP, ms2), мощность очень низких (VLF, ms2), низких частот (LF, ms2) и высоких (HF, ms2) частот доменов спектра ВСР в 5-минутных интервалах ЭКГ в I стандартном отведении. Данные были обработаны методами непараметрической статистики. Установлено, что спектральные характеристики вариабельности сердечного ритма у добровольцев с нормальным ИМТ имеют высокую TP с гармоничным соотношением между доменами VLF, LF, HF; снижение или повышение ИМТ провоцирует снижение TP за счет уменьшения мощности всех спектров ВСР (VLF, LF, HF) с преобладанием доли VLF и этот эффект возрастает с увеличением степени отклонения параметра.

КЛЮЧЕВЫЕ СЛОВА: вариабельность сердечного ритма, индекс массы тела, условно здоровые добровольцы

INTRODUCTION

Body mass index (BMI) is one of the most important physiological characteristics of the body and reflects matching of the weight of the person to its growth [1]. The use of this parameter in clinical practice will help to establish the deficit, excess body weight and obesity of varying degree.

Heart rate variability (HRV) is the earliest indicator of violations of adaptation reserves of the body and has important prognostic value for both healthy people and patients with diseases of various organs and systems [2].

Taking into account that the variability of body weight can be considered as a failure of the adaptation to environmental conditions [3], it is interesting to assess the state of human regulatory systems based on spectral characteristics of HRV in conditionally healthy volunteers with different BMI.

The study was performed as part of KhNU scientific research «Development and research of system of automatic control of heart rate variability», № registration 0109U000622.

OBJECTIVE

Purpose of the study is to explore the dependence of spectral characteristics of heart rate variability from body mass index in conditionally healthy volunteers.

MATERIALS AND METHODS

The study involved 43 volunteers aged from 19 to 30 years (average age is 24,5 ± 5,0 years). Inclusion criteria: age over 20 years, absence of acute and chronic diseases, absence of pernicious habits.

BMI was assessed on the basis of the formula BMI = m/h, where m – the weight in kilograms, h – growth in meters [1]. According to WHO guidelines for BMI interpretations [1] were such groups of volunteers: underweight, normal body weight, overweight, obesity I degree, obesity II degree, obesity III degree (table).

Table

Characteristic of groups of volunteers

Groups of volunteers	**BMI (kg/m^2)**	**Number of volunteers (n)**	**Average age (M ± sd)**
Underweight	16 – 18,5	20	22,7 ± 3,2
Normal weight	18,5 – 25	25	22,5 ± 2,9
Overweight	25 – 30	20	23,5 ± 6,2
Obesity I degree	30 – 35	15	24,1 ± 4,1
Obesity II degree	35 – 40	17	28,1 ± 10,0
Obesity III degree	more than 40	5	26 ± 3,6

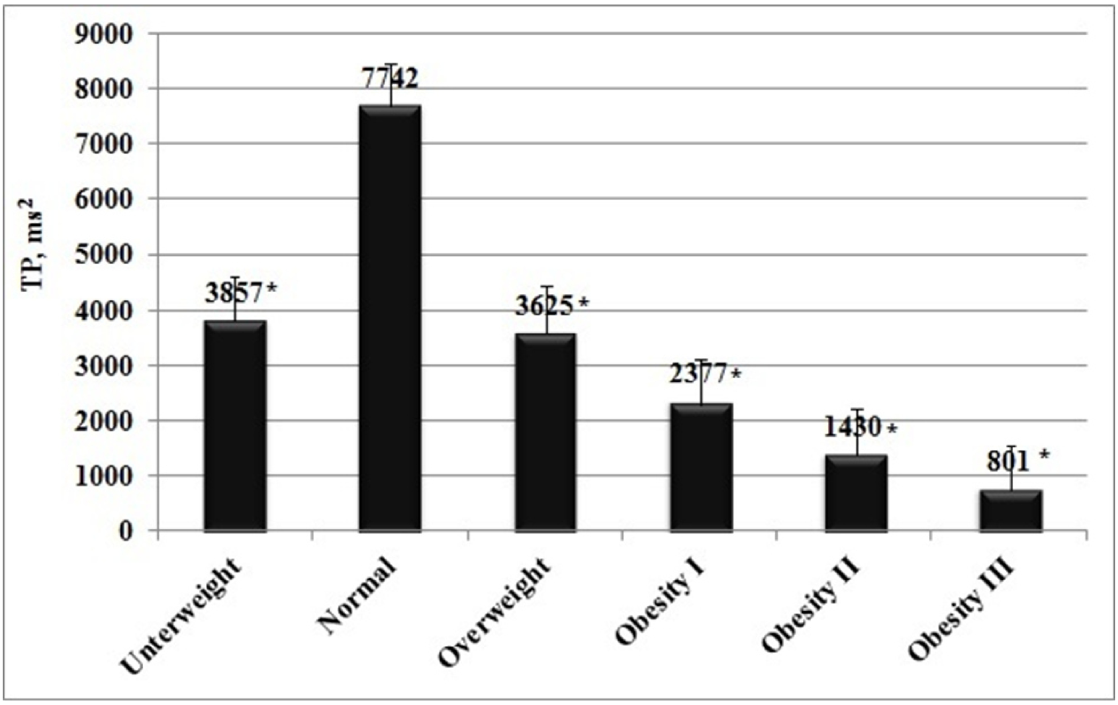
Note: $p < 0{,}01$ between groups

Among HRV parameters were evaluated total power (TP, ms2), power of very low frequency (VLF, ms2), low frequency (LF, ms2) and high frequency (HF, ms2) domains of HRV spectrum in the 5-minute intervals of ECG in I standard lead [2] on the diagnostic complex «Cardiolab 2009».

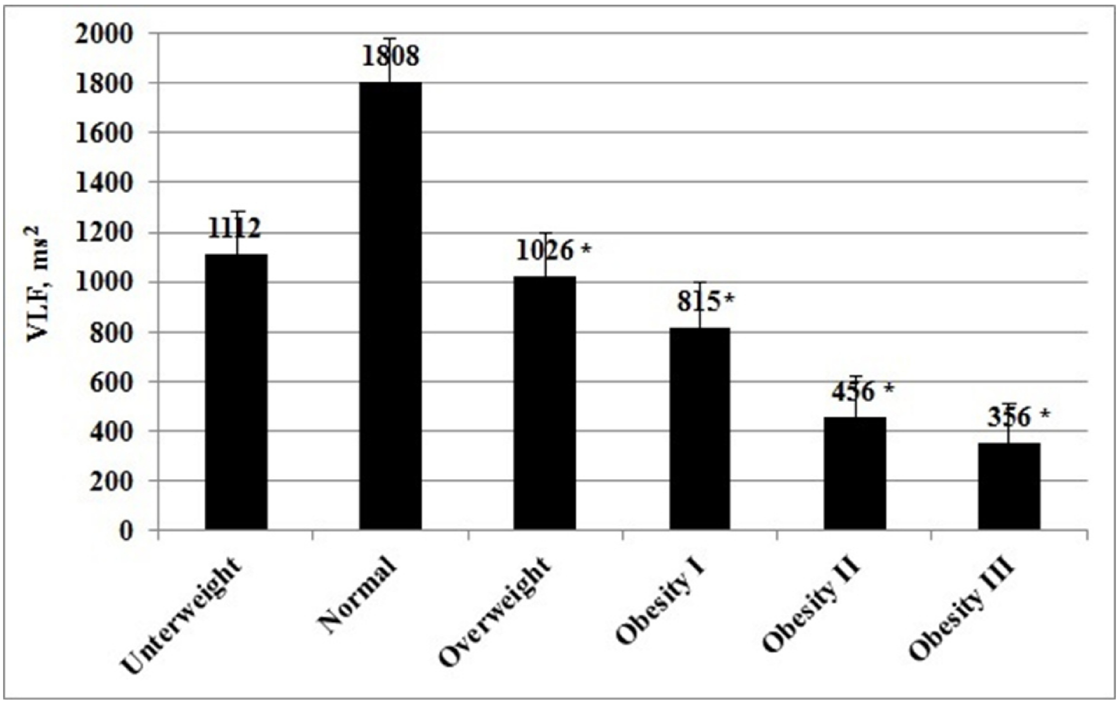
Statistical analysis of the results for each subject was carried out using Microsoft Excel. Average values (M) and standard deviations (sd) of TP, VLF, LF and HF of all records of all subjects were put down in spreadsheet. The differences reliability of each parameter between groups of volunteers was determined by Mann-Whitney U-test [4].

RESULTS AND DISCUSSION

Average values (M) and standard deviations (sd) of TP, VLF, LF and HF in all groups of volunteers presented in figure. Spectral characteristics of HRV in patients with normal BMI have a high TP with harmonious relations between VLF, LF and HF domains. All BMI abnormalities provoke TP reduction by decreasing power of all domains of HRV (VLF, LF, HF) and this effect increases with the degree of deviation.



a)



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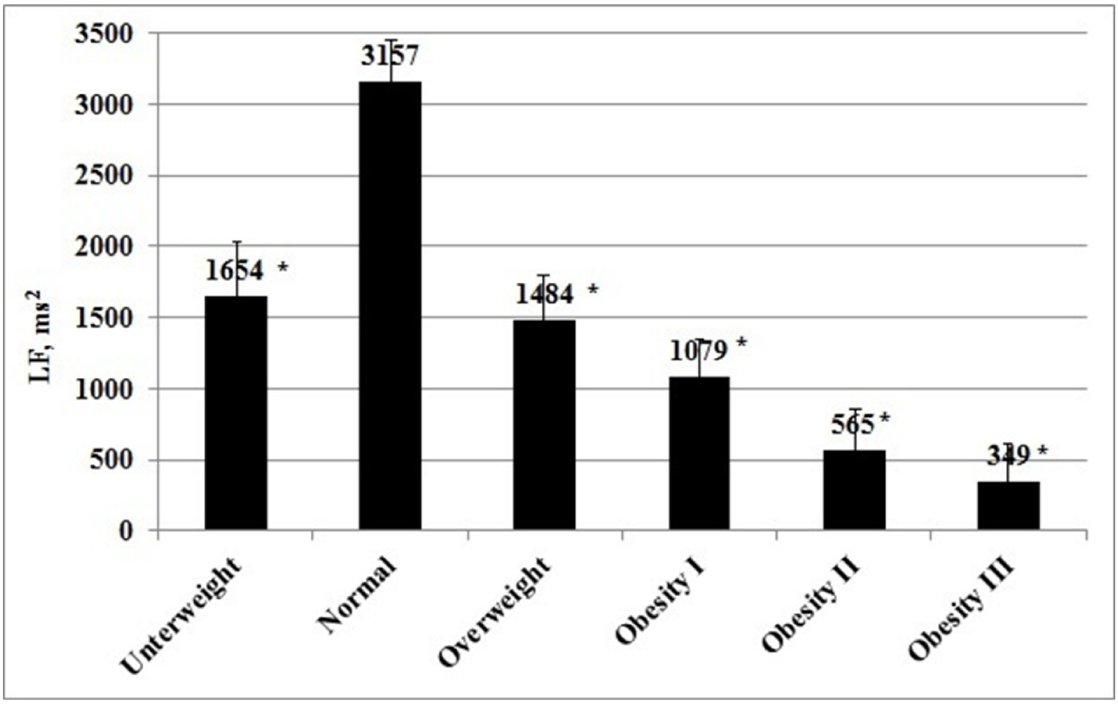
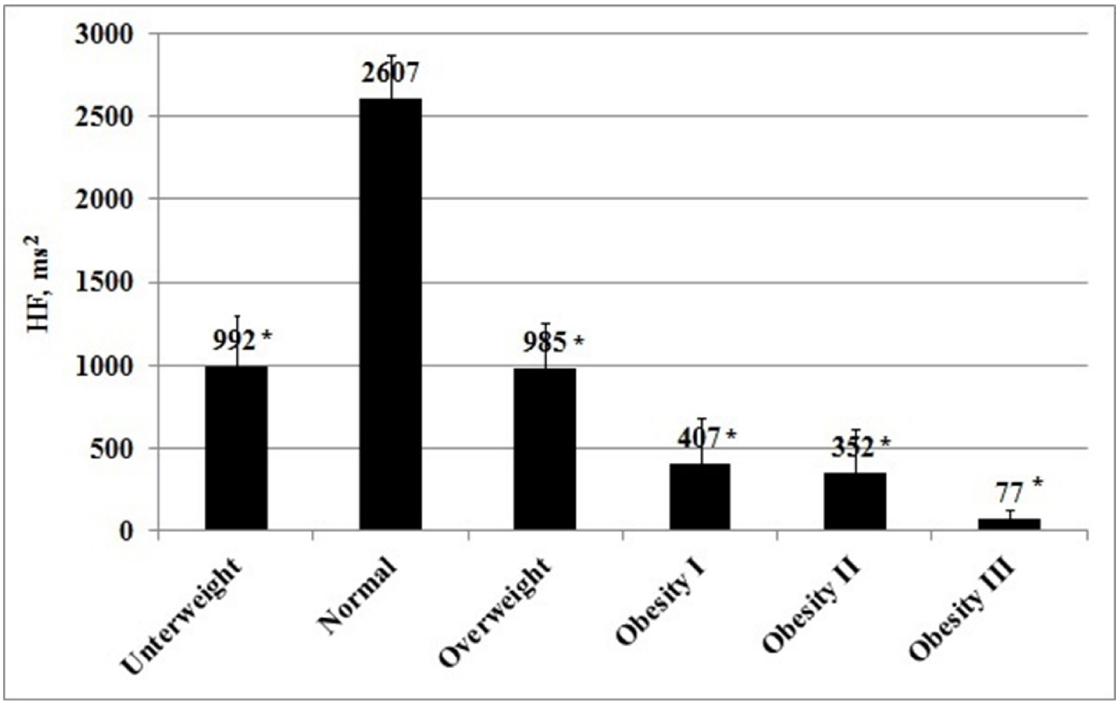


c)



d)

Fig. Average values (M) and standard deviations (sd) of TP (a), VLF (b), LF (c) and HF (d) in volunteers with underweight, normal body weight, overweight, obesity I degree, obesity II degree, obesity III degree.

Notes: p < 0,01 against volunteers with normal body weight.

Several studies [5–7] have shown that the lack or excess weight can be seen as a failure of adaptive reserves of the human body; however, there are no accurate data on the specific changes in the autonomic regulation in the literature, which makes our investigation topical.

Among the non-invasive assessment of the state of the regulatory systems techniques heart rate variability (HRV) is the most informative and widely used in clinical practice [2]. BMI is a versatile and most convenient means of evaluating body weight, which allowed identifying underweight, normal body weight, overweight, obesity I degree, obesity II degree, obesity III degree [1].

We have found that spectral characteristics of HRV in patients with normal BMI have a high TP (7742 ms^2) with harmonious relations between VLF (23 %), LF (43 %) and HF (34 %) domains. In volunteers with unter- and overweight was observed practically same reduction of TP (3857 and 3625 ms^2 against 7742 ms^2 in volunteers with normal BMI) by all domains (VLF, LF, HF), but with preservation of their proportions. In volunteers with obesity was observed increases with the degree reduction of TP by declining power of all domains of HRV (VLF, LF, HF) with a predominance of VLF proportion.

CONCLUSIONS

1. Spectral characteristics of HRV in patients with normal BMI have a high TP with harmonious relations between VLF, LF and HF domains.
2. Decreased or increased BMI provokes TP reduction by declining power of all domains of HRV (VLF, LF, HF) with a predominance of VLF proportion.
3. TP reduction with declining power of all domains of HRV (VLF, LF, HF) with a predominance of VLF proportion increases with the degree of deviation of BMI.

PROSPECTS FOR FUTURE STUDIES

It is interesting to evaluate the volatility of spectral parameters of HRV in conditionally healthy volunteers with normalizing of BMI by dietary recommendations.

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