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INFLUENCE OF THE REGULAR YOGA PRACTICE ON THE HEART RATE VARIABILITY OF THE OVERWEIGHT INDIVIDUALS

Abstract. *Purpose of the work was to investigate the influence of the regular Yoga practice to the heart rate variability of the persons with overweight. Materials and methods: 32 overweight previously non-yoga practitioners were investigated during 24 weeks since beginning of regular Yoga practice. Main anthropometric, hemodynamic and heart rate variability parameters were analyzed trice (Week 0, 12 and 24), and received data were compared with parameters of 16 normal weight persons. Heart rate variability investigation was provided on the cardiac monitor "Diacard" AO "Solveig" (Ukraine). Results: We found out the significant reduction of the time and spectrum heart rate variability parameters of parasympathetic heart function regulation in overweight subjects before beginning of the regular Yoga practice. Dynamic control discovered progressive positive influence of Yoga to autonomic cardiac regulation with significant growth of parasympathetic activity and normalization of sympathetic/ parasympathetic balance with strong tendency to decreasing of resting heart rate, systolic and diastolic blood pressure, body weight, body mass index and waist circumference. Correlation analyze detected negative dependence between waist circumference and reduction of parasympathetic influence to the heart activity. Conclusions: The regular Yoga practice prominently improves the balance of autonomic regulation because of significant growth of parasympathetic influences and reduction of sympathetic stimulations of the heart function of overweight persons.*

Key words: *Yoga practice, obesity, overweight, heart rate variability.*

Introduction. The overweight and obesity was accepted by WHO as the major public health problem and the global pandemic in 1997 [17]. In 2015, a total of 107.7 million children and 603.7 million adults were obese. Since 1980, the prevalence of obesity has doubled in more than 70 countries and has continuously increased in most other countries. High body mass index (BMI) accounted for 4.0 million deaths globally, nearly 40% of which occurred in persons who were not obese. More than two thirds of deaths related to BMI were due to cardiovascular disease [5, 10, 16].

Many factors play a role in the relationship between overweight and cardio-vascular diseases (CVD), such as insulin resistance, hypertension, and reduced high-density lipoprotein. However, an imbalance in autonomic regulation of the cardiac function might be the mechanism for the increased prevalence of CVD in obesity [9]. 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 [14, 18].

Heart rate variability (HRV) is a simple non-invasive instrumental method for the detection and investigation of cardiac autonomic dysfunction in different medical conditions, including obesity [3]. Low HRV is an established predictor of CV morbidity and mortality [11, 13].

Major health organizations, such as the International Association for the Study of Obesity (IASO) and the American College of Sports Medicine (ACSM), consistently support the need for more than 150–250 min/week of moderate-intensity physical activity to prevent weight gain. However, there is currently a lack of guidance for obese individuals on feasible strategies for weight loss and prevention of weight regain [12]. Yoga is an ancient system of practices based on the scientific principles of exercise, breathing and meditation, and philosophical beliefs concerning life and thinking. The origin of yoga has been ascribed to the Indus Valley Civilization (2600-1900 BCE) although some researchers suggest more ancient origins. Participation in yoga has increased dramatically throughout the world in recent decades. Many styles of yoga have been tested in the clinical setting and most involve the performance of physical postures (*asanas*), breathing exercises (*pranayama*) and meditation [4, 6].

A growing number of research studies have shown that the practice of Yoga can improve strength and flexibility, and may help control such physiological variables as blood pressure, respiration and heart rate, and metabolic rate to improve overall exercise capacity [7, 8, 15]. Investigations suggest that Yoga practice is effective for decrease of the general stress, awareness on satiety, positive influence for over eating and weight reduction [2].

However, the chronic effects of Yoga training on HRV in obese persons and its correlation with anthropometric characteristics improvement remain inconclusive and need to be investigated.

The purpose of the work was to investigate the influence of the regular Yoga practice to the heart rate variability of the persons with overweight.

Materials and methods. 32 overweight previously non-yoga practitioners were investigated during 24 weeks since beginning of regular Yoga practice. There were 18 female and 14 male persons with BMI >25 kg/m^2 and from 25 to 47 years of age (40,3±2,4 y.o.). All investigated persons have agreed to participate in an experiment. Comparative analyses of HRV parameters was conducted with data of 16 non-obese subjects with the same age/gender characteristics. Informed written consent was taken from all the subjects and they were screened for any history of drugs/alcohol intake, familial history of hypertension and cardiac diseases, or presence of any medical illness likely to affect the HRV parameters based on clinical history and physical examination. Yoga training was conducted three times in a week; every class lasted 90 min and consisted of asanas, pranayama and meditation under the supervision of the experienced Yoga master. HRV investigation was provided trice (beginning of Yoga practice and after 12 and 24 weeks) in comfortable conditions. The blood pressure of each subject was measured in supine position. Analysis of HRV was performed based on 5 min ECG recorded at rest in the supine position. Recordings were taken during 08:00 am – 11:00 am to avoid any hemodynamic effect on HRV on the cardiac monitor "Diacard" AO "Solveig" (Ukraine). HRV analyses and results estimation were based on the classic approach for analysis of variability of heart rate that is recommended by the European society of cardiology and North American society of pacing and electrophysiology [1]. The parameters of autonomic regulation of heart rate and results of spectral analysis were registered; and received data were calculated via support of statistical program «Kubios HRV". Statistical analysis was performed with Statistical Package for the Social Sciences software for Windows (version 21). Differences in variables were tested using Mann–Whitney U test for the data having nonparametric distribution and Student's t-test for the data with parametric distribution. The results were presented as mean ± standard deviation (SD). Pearson's correlation was used to correlate the HRV measures and the obesity indices. Statistical significance was considered to be p<0.05.

Results. The anthropometric characteristics of the investigated subjects present in the Table 1. It shows comparable age of overweight and non-overweight subjects with prominent differences in the body weight (BW), BMI and waist circumference (WC) between groups.

The time domain, frequency domain variables of HRV of both the groups were calculated and are presented comparatively in Table 2. Among the time domain measures, SDNN, RMSSD, and pNN50% were calculated. All these time domain variables were significantly less (p<0.05) in the overweight group as compared to the normal weight group. Spectral parameters – high-

Table 1

Baseline characteristics of overweight and non-overweight subjects

Characteristic	Control group (n=16)	Total cohort (*n* = 32)	Male (*n* = 14)	Female (*n* = 18)
Age (y)	41,.2±3,5	40,3±2,4	38,2±10,1	42,3±11,4
Body weight (kg)	76,8±6,3	95,5±16,3	89,4±12,2	97,3±14,2
BMI (kg/m^2)	23,4±2,1	30,5±4,2	29,9±5,1	30,9±3,3
Obese (BMI 30+) (n; %)	0; 0%	11; 34%	5; 36%	6; 33%
Waist circumference (cm)	81,3±8,4	94,7±14,7	93,9±14,5	95,3±15,1

frequency component of the spectrum, HF (ms^2), low frequency component of the spectrum – LF (ms^2) also were significantly reduced in overweight subjects. However, the LF/HF ratio as an indicator of the balance of sympathetic and parasympathetic autonomic regulation and one of the indirect sympathetic marker in overweight subjects exceeded the same one from the non-obese persons.

Next HRV investigations on the Week 12 and Week 24 of the regular Yoga practice we conducted to detect possible influence of that exercise complex to the autonomic regulation of the cardiac functions. Received data are presented in the Table 3 and suggest significant (p<0.05) growth of the main time and spectrum characteristics of HRV in overweight persons during continuous Yoga practice.

Dynamic investigation of the resting heart rate (RHR), systolic (SBP) and diastolic blood pressure (DBP), BW and BMI (Table 4) revealed tendency of the positive influence of the regular Yoga training to investigated characteristics of overweight persons. We concluded that all investigated parameters progressively decreased partially coming into normal ranges in some subjects. BW and BMI normalized in 4 obese (36%) and 6 overweight persons (29%).

Table 2

Comparison of HRV measures between overweight and normal weight groups

Variables	Overweight subjects (n=32)	Control group (n=16
SDNN (ms)	32,4±8,7	44,5±7,6 *
RMSSD (ms)	26,5±4,5	42.7±9,8 *
PNN50%	5,8±1,5	21,6±6,4 *
LF ms^2	252,9 ±28.3	456,7±56,9 *
HF ms^2	165,5±38,7	530,5±112,7 *
LF/HF	1.2±0.95	0.67±0,8 *

*Note: * - p < 0,05, comparing with the control group*

Table 3

Dynamics of HRV characteristics of the overweight subjects during investigation

Variables	Week 0	Week 12	Week 24
SDNN, ms	32,4±2,7	37,5±3,4	41,4±4,7 *
RMSSD, ms	26,5±4,5	32,6±6,3	38,7±5,9 *
pNN50, %	5,8±1,5	12,4±3,5	15,8±5,2 *
LF, ms^2	252,9 ±28.3	354,4±46,8	398,5± 56,8 *
HF, ms^2	195,5±38,7	365,7± 82,7	464,3±91,7 *
LF/HF ratio	1,2±0.95	0.97 ± 0.95	0.86 ± 0.95 *

*Note: * - p < 0,05, comparing between week 0 and week 24*

Table 4

Changes of hemodynamic and anthropometric characteristics during investigation (n=32)

Parameters	Week 0	Week 12	Week 24
Resting heart rate (bpm)	78,3±8,5	73,9±6,3	67,4±9,1
Systolic blood pressure (mmHg)	134,3±5,6	130,5±6,3	126,8±8,1
Diastolic blood pressure (mmHg)	85,7±5,9	82,5±6,7	77,1±5,4
Body weight (kg)	95,5±16,3	93,7±11,5	89,8±9,9
Body mass index (BMI) (kg/m^2)	30,5±4,2	28,8±5,3	26,4±3,7

Correlation indexes were calculated to reveal possible dependence between HRV data and anthropometric and hemodynamic parameters of the investigated subjects. Moderate negative correlation was detected between WC and HF (r=-0,412), WC and RMSSD (r=-0,324), WC and SDNN (r=-0, 432), BMI and DBP (r=-0,375), RHR and SDNN (r=-0,356), RHR and HF (r=-0,432). However, positive correlation was revealed between LF and WC (r=0,441), LF/HF and WC (r=0,318). Other HRV parameters were not significantly correlated with anthropometric and hemodynamic characteristics of the observed individuals.

Discussion. In present work, we investigated influence of the 24-weeks Yoga practice to HRV variables of 32 overweight person. Comparative analyses was conducted with normal-weight subjects comparable in terms of their age and general health characteristics. However, obese persons had significantly higher BW, BMI, and WC than normal weight controls. The resting heart rate was significantly higher in the overweight subjects in comparing to the normal-weight group, which corresponds to several studies about finding of tachycardia in obese people as risk factor of the CVD [5].

The HRV variables SDNN, RMSSD, pNN50, HF indices that reflect the cardiac parasympathetic nerve activity [13] were significantly lower in overweight than in normal weight persons. Besides that, the sympathetic marker LF/HF ratio significantly exceeded in obese subjects in comparison to normal weight controls. According to studies, obese and overweight persons suffer from an increased mortality risk supposedly due to CVD related to either continuously lowered parasympathetic or heightened sympathetic activation [11, 14].

Moreover, correlation analysis showed that the HRV parasympathetic variables, like SDNN, RMSSD, HF ms^2, were negatively dependent from WC, while RHR had moderate positive relation with LF and LF/HF ratio. Based on absence of any significant dependence between HRV parameters and BMI, we can suggest that WC is the more important predictor of CVD in overweight subjects, which should be carefully controlled and corrected by physical exertions.

Taking for attention, that Yoga practice tends to be very popular all over the world, it was important to analyze it\`s positive effects for reduction of the CVD risks including dysregulation of the sympathetic-parasympathetic balance. Although the mechanism by which yoga influences autonomic activity is not well investigated, regular Yoga practice appears to directly stimulate the vagal nerve and enhance parasympathetic output leading to parasympathetic dominance and normalization of the cardiac function, mood, and energy states, as well as stimulation of neuroendocrine, metabolic, cognitive, and immune responses.

Our work shows not only progressive positive anthropometric (reduce of BMI, WC, BW) effects from the regular Yoga training of the overweight persons, but also sufficient hemodynamic (decrease RHR, SBP, DBP) results and significant positive influence to HRV parameters with tendency to normalization of the main time and spectrum variables (SDNN, RMSSD, pNN50, LF, HF, LF/HF ratio). 24 weeks\` Yoga practice realized adequate stimulation of the parasympathetic regulation of heart function in overweight subjects leading to reduction of cardio-vascular risks. During the period of supervision, BMI, WC, BW and HRV variables had strong tendency to normalization, but did not fully came into normal ranges. According to that, continuation of regular Yoga training is strongly recommended for this category of persons.

Conclusions. Time (SDNN, RMSSD, pNN50) and spectrum (HF, LF/HF ratio) HRV parameters of parasympathetic part of cardiac function regulation in overweight persons were significantly ($p<0,05$) reduced in comparing with normal-weight subjects, suggesting about complex negative influence of obesity as a predictor of cardiac problems. Negative moderate correlation between parasympathetic variables of HRV and WC, also positive moderate correlation between sympathetic spectrum variables (LF, LF/HF) and WC without strong relationship between HRV parameters and BMI recognize the abdominal type of overweight as more important negative factor of vegetative dysregulation.

The regular Yoga practice helps in balancing of autonomic regulation because of significant growth of parasympathetic influences and reduction of sympathetic stimulations of the heart function, which was confirmed by HRV monitoring and dynamic analyzes of hemodynamic parameters (resting heart rate, systolic and diastolic blood pressure) of overweight persons.

Heart rate variability test is a modern, non-invasive adequate method of estimation of the heart function\`s autonomic regulation in overweight subjects and may be used not only for evaluation of the predictors of cardiac problems but also as an objective reflection of positive changes of health during physical training.

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