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Original Article

Physical and psychological deconditioning of overweight middle-aged women caused by Covid-19

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Abstract:
The study was aimed at identifying the structure of relationships between the psychological and morphological state of overweight and obese women under conditions of quarantine restrictions related to COVID-19 pandemic. The following methods were used: anthropometric, to determine the body measurements; bioimpedance analysis, to assess the body composition; physiological, to study the cardiovascular and respiratory systems; psychological, to examine the psycho-emotional sphere; statistical analysis, to objectify the obtained results. The article presents a comparative analysis of the morpho-functional and psychological state of women aged 35-42 years over the seven months of quarantine restrictions caused by the spread of COVID-19. Analysis of the data revealed significant negative changes in the indicators of physique and psychological state of women over this period. In women, body weight increased on average by 10.2% ($p<0.05$), and waist and abdomen circumferences increased by 9.9% ($p<0.05$) and 12.5% ($p<0.05$), respectively. A lack of regular physical activity was one of the factors increasing the fat mass by 22.7% ($p<0.05$) and decreasing the muscle mass by 23.9% ($p<0.05$). In women, the zest for life decreased by 37.0% ($p<0.05$) and the congruence between desired and achieved goals decreased by 64.6% ($p<0.05$). The overall psychological state of women deteriorated by 39.4% ($p<0.05$) and began to indicate a high level of emotional stress, low emotional stability, high level of anxiety, and psychological discomfort. Correlation analysis revealed high negative correlations between psychological and morphological indicators, which ranged from $r=-0.321$ (at $p<0.05$) to $r=-0.683$ (at $p<0.001$). The findings of this study suggest that a sedentary lifestyle and low level of physical activity over the quarantine restrictions period had a negative impact on the morpho-functional state and quality of life of women. The fear of COVID-19 infection caused women to become depressed and anxious; whereas uncertainty about the future threatened the mental state of the subjects.
Key words: pandemic, physical activity, quarantine restrictions, emotional state, physique

Introduction

Current challenges facing the world today, namely the spread of COVID-19 and the consequences of quarantine and human isolation, have led to a rethinking of the priorities of human life and the importance of physical activity for human health (Iannaccone et al., 2020; Hammami et al., 2020; Woods et al., 2020). Recent research data indicate that overweight and obesity are major factors contributing to complications and high mortality from COVID-19 (Michalakis et al., 2020; Stefan et al., 2020; Tu-Hsuan Chang et al., 2020). Physical activity remains one of the main means of preventing the development of obesity, weight management, and improving physical condition (Andrieieva et al., 2020; Drozdovska et al., 2020; Hakman et al., 2019; Galan et al., 2019 a, b; Kashuba et al., 2019). These two types of modern pandemics, obesity and COVID-19, are interrelated in different ways. Researchers report that overweight and obesity can significantly complicate the course of COVID-19 (Yang et al., 2020).

On the one hand, obesity complicates the diagnosis and intubation of patients with COVID-19; creates additional difficulties for the health care system related to the transportation of obese patients, the need for special equipment and personnel, according to the World Obesity Federation, which brings together scientists and health professionals from more than 50 countries of the world (Tara et al., 2020; Jackson et al., 2020). On the second hand, obesity is associated with a high risk of severe symptoms and complications of COVID-19 (Stefan et al., 2020; Jun Yang et al., 2020). The third aspect is that the effects of self-isolation and reduced physical activity of large groups of people contribute to the expansion of overweight and obesity (Narici et al., 2020). Although it is generally accepted that comorbid diseases such as hypertension, diabetes, and cardiovascular disease are associated with a complicated course of COVID-19, the role of overweight and obesity has so far been little studied.

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Researchers emphasize the problem of deterioration of physical and emotional state due to reduced physical activity caused by COVID-19 quarantine (Ammar et al., 2021; Jeffrey et al., 2021). The authors note that in people who were exercising regularly before the pandemic, a significant decrease in physical activity can result in metabolic and functional decline, loss of muscle mass, and mental disorders (Booth et al., 2012; Dunton et al., 2020; Faulkner et al., 2020; Mozolev et al., 2020; Peçanha et al., 2020).

The authors note that the engagement in an appropriate level and intensity of physical activity is effective to prevent and overcome the consequences of the COVID-19 pandemic (Chen et al., 2020). Physical activity has a profound preventive potential against many chronic diseases that are risk factors for COVID-19 (Bentlage et al., 2020). Numerous international studies have demonstrated the negative effects of quarantine-related restrictions on the physical and emotional condition of people of all ages (Kaur et al., 2020). This is due to significant changes in the lifestyle of the population, in particular with a significant decrease in the level of daily physical activity, the inability to attend fitness clubs (Piotrowski et al., 2021). The authors point to the prevalence of adverse health effects of sedentary behavior (Raiola et al., 2021). According to scientists, a decrease in physical activity, social isolation, increased anxiety due to the possibility of getting sick, insecurity, and confusion lead to an increase in physical and mental health problems (Jiménez-Pavón et al., 2020; Mozolev et al., 2020). Studies indicate that social isolation has led to a 28% increase in sedentary lifestyles and unhealthy eating behavior (Ammar et al., 2020). Studies among girls aged 17-19 years showed that a decrease in physical activity caused by the pandemic led to a deterioration in the cardiorespiratory function including an increase of 3.82% in blood pressure and of 1.83% in resting heart rate (Mozolev et al., 2020). Studies conducted by Adamakis (2021) with middle-aged men also showed a deterioration in sleep quality and weight gain as a result of quarantine-related restrictions.

Although scientists have systematized some aspects of scientific knowledge about the negative effects of pandemic-related restrictions, however the deterioration of the physical and mental condition of overweight middle-aged women has not been studied specially.

Materials and Methods

The study involved 48 women aged from 35 to 42 years. The sample of women who participated in the study was at risk because they were overweight or obese; the measured values of abdomen circumference indicated abdominal obesity. The study was conducted at the National University of Ukraine on Physical Education and Sport (Kyiv, Ukraine). Ethical approval was obtained from the Ethics Commission of the NUUPES (No. 2 on 16.12.2020). Participants of the study were informed about the objectives, methods, and procedures of the study and their written informed consent was obtained.

Inclusion criteria for the women were as follows: women between the ages of 35 and 45, received medical clearance to participate, and provided informed consent. Exclusion criteria were: diagnosis of type I diabetes mellitus and/or hypertension; decompensated state at the beginning of the study; taking weight-loss, antihypertensive or insulin-resistance drugs; pregnancy; inflammatory disease in the acute phase. The present study was conducted with women for whom going to the fitness center was a routine activity.

Anthropometric methods that provided quantitative measurement of physique indicators were used in compliance to international standards. The height, body weight, and circumferences of the chest, abdomen, waist, and hips were measured. These measures were used to calculate the body mass index (BMI), waist-to-height ratio (WHtR), and waist-to-hip ratio (WHR). The following equations were used to calculate these indexes: BMI = body weight (kg) / body height $(m)^2$; WHtR = waist circumference (cm) / body height (cm); WHR = waist circumference (cm) / hip circumference (cm). The obtained values were scored as follows: BMI<16 – severely underweight; 16.0-18.5 – underweight; 18.5-25.0 – normal body weight; 25.0-30.0 – overweight; 30.0-35.0 – obese class I; 35.0-40.0 – obese class II; >40.0 – obese class III. WHtR <0.35 – severely underweight; 0.35-0.42 – underweight; 0.42-0.49 – normal body weight; 0.49-0.54 – overweight; 0.54-0.58 – severely overweight; >0.58 – obese. WHR<0.80 – normal body weight; 0.80-0.84 – overweight; >0.85 – obese. The composition of the body was evaluated using a Tanita Segmental Body Composition Monitor BC-545.

The functional state of the cardiovascular system was monitored using the method of continuous recording of heart rate using a heart rate monitor Polar Unite (Finland) and Polar Flow application via Bluetooth Smart®. Blood pressure measurements were performed using a Digital Blood Pressure Monitor UA 767 (AND, Japan) in the sitting position in a state of relative rest. BP readings were taken twice with a 5-min interval, and the average of the measurements was recorded in mmHg. The obtained data were used to determine the relationship between blood pressure and heart rate. Pulse pressure (PP), which reflects the kinetic energy of blood flow and normally ranges from 30 mmHg to 45 mmHg, was calculated as follows: PP = systolic BP – diastolic BP. The coefficient of endurance was calculated using the equation: CE = HR×10/ATp; the normal range is 12 to 15 arb.units. The level of the tension of regulation mechanisms of the cardiovascular system was determined from the type of self-regulation of the blood circulation calculated using the following equation: TSC = BPdia / HR×100. The TSC was scored as follows: 90–110 – cardiovascular type; >110 – vascular type; <90 – cardiac type of the regulation mechanisms. Cardiac index (CI) is the ratio of cardiac output to the person's body surface area. It was calculated as follows: CI = CO / BSA ($L \cdot min \cdot m^{-2}$), where CO is the cardiac output and BSA is the body surface area. The normal range for cardiac index is about 2.5-3.2 ± 0.3 $L \cdot min \cdot m^{-2}$. Hypokinetic (less

than 2.5 L·min·m^{-2}) and hyperkinetic (more than 3.5 L·min·m^{-2}) types of regulation were considered as a deviation from the norm. The values of the stroke volume index (SVI) characterize the type of hemodynamics. This index was calculated with the equation: SVI=CO×BSA/HR, where CO is the cardiac output, BSA is the body surface area, and HR is the heart rate. The obtained values were scored as follows: 39.5-54.5 mL·m^{-2} is eukinetic; less than 39.5 mL·m^{-2} is hypokinetic; and more than 54.5 mL·m^{-2} is hyperkinetic type of hemodynamics. The functional state of the respiratory system was assessed using conventional methods. Noninvasive measurement of capillary blood oxygen saturation was performed using a medical pulse oximeter LK87/88/89. To measure saturation, a pulse oximeter was placed on the tip of the index finger or of the second toe, or on the earlobe when the subject has gel polish on the nails. After a few seconds, the blood oxygen saturation (SpO2) and heart rate were measured. The values of 96% or above were considered as normal. Respiratory rate (RR) was determined over 3-5 minutes, the normal range for adults was 16-18 breaths/min. Index of hypoxia (IH) was calculated using the equation: IH=BHTexh/HR, where BHTexh is the time of breath-hold after exhalation in seconds and HR is the heart rate in bpm. This index characterizes the body's tolerance to oxygen deficit. The normal range of IH for healthy untrained women is 0.369–0.546 arb.units. To assess the psychological state of women, we used the Life Satisfaction Index A (LSIA) developed by Bernice L. Neugarten (1961) and adapted by N.V. Panina (1993). The research was conducted using the measuring instruments that meet the necessary metrological requirements. The measurement accuracy was ensured by the laboratories that have internationally recognized calibration and measurement capabilities for the relevant types of measurements. The results of the study were subjected to statistical data analysis. The following descriptive statistics of the sample were calculated: arithmetic mean (M), standard deviation (SD). A confidence interval (CI) of 95% was used. Student's t-test was used to compare two normal distributions. When at least one of the samples was not normally distributed, Wilcoxon rank test was used to compare independent samples. A significance level of $p<0.05$ was chosen to test statistical hypotheses. Correlation analysis of the obtained data was performed using a linear Pearson correlation coefficient.

Results

The study was focused on assessing the impact of restrictive measures related to COVID-19 on the psychophysical condition of overweight middle-aged women. The study involved 48 women with an average age of 38.6 years. It should be noted that this sample of women was characterized as a socially active population. All women were regular clients of the Olympic style fitness center, who had an annual pass and attended training sessions more than three times a week. The majority of women (39.6%) were private entrepreneurs engaged in trade, 31.2% were employed in the service sector, 14.6% worked in the education sector, and 14.6% were economists and lawyers. The form of occupational activity of the women is associated with a dynamic rhythm of life and social activity. The data presented in Table 1 demonstrated that the group means of the morpho-functional condition variables of women before quarantine were slightly deviated from the age-related physiological norms. Among the women, 8.3% had class I obesity that, in turn, negatively affected the function of the cardiovascular system.

Table 1. Changes in the means of the morpho-functional condition variables of middle-aged women over seven months of 2020 (n=48)

Parameter	Values on 01.03.2020		Values on 01.10.2020		CI	p
	M	SD	M	SD		
Height, cm	165.3	2.16	165.3	2.81	2.3	>0.05
Body weight, kg	69.3	5.13	76.4	6.32	4.0	<0.05
BMI, kg·m^{-2}	25.3	0.35	28.7	0.92	0.4	>0.05
Body surface area, m^2	1.8	0.07	2.2	0.16	0.1	<0.05
Waist circumference, cm	80.9	4.18	88.9	7.31	5.1	<0.05
Abdomen circumference, cm	87.3	3.67	98.2	4.25	3.7	<0.05
Hip circumference, cm	106.1	4.47	114.9	9.22	6.4	<0.05
Waist-to-hip ratio (WHR), arb. un.	0.74	0.04	0.83	0.06	0.1	<0.05
The waist-to-height ratio (WHtR), arb. units	0.48	0.03	0.55	0.04	0.1	<0.05
Fat mass, %	31.7	5.76	38.9	2.69	3.1	<0.05
Muscle mass, %	39.7	2.80	30.2	1.65	1.8	<0.05
Heart rate, bpm	75.2	4.26	81.7	5.12	4.6	<0.05
BPsys, mmHg	125.4	10.21	137.8	11.26	10.4	<0.05
BPdia, mmHg	84.6	6.33	86.3	11.22	8.1	>0.05
Pulse pressure, mmHg	43.9	3.28	45.6	5.19	3.6	>0.05
Coefficient of endurance, arb. un.	13.9	2.01	17.8	4.77	3.1	<0.05
Cardiac index, L·min·m^{-2}	2.8	0.72	1.8	0.44	0.4	<0.05
Stroke volume index, mL·m^{-2}	91.5	16.24	95.3	25.20	18.2	<0.05
Oxygen saturation, %	97.2	1.14	96.8	1.33	1.1	>0.05
Respiratory rate, breaths/min	17.6	1.04	22.4	2.65	1.3	<0.05
Index of hypoxia, arb.un.	0.320	0.05	0.250	0.07	0.1	<0.05

As can be seen from Table 1, statistically significantly ($p<0.05$) changes occurred in the body measurements during the quarantine period that negatively affected the functional indicators of the cardiovascular and respiratory systems of women. These negative changes were due to the lack of regular physical activity for almost six months. Women gained on average seven kilograms of body weight during the period of restrictive measures due to COVID-19. The waist circumference values significantly exceeded the normal range and indicated the presence of abdominal obesity. WHTR and WHR values were found to change negatively and fell in the range associated with overweight.

Analysis of the function of the cardiovascular system before and after the period of quarantine measures indicated statistically significant ($p<0.05$) negative changes in almost all studied parameters. Thus, the group mean of resting heart rate, as an integral indicator of the function of the circulatory system, fell outside the normal range. Negative changes in the morphological status affected the systolic blood pressure, which is believed to be an indicator of homeostasis, and, therefore, its deviation may indicate certain changes in the general functional condition of the body. A statistically significant ($p<0.05$) increase in the group mean of the coefficient of endurance was observed, thus indicating decreased function of the cardiovascular system. In women, respiratory rate increased and the index of hypoxia decreased. This negative trend in the variables of the functional condition indicates an impairment of compensatory mechanisms.

Similar negative changes occurred also in the indicators of the psychological state of women. As can be seen from Table 2, before quarantine, women had a positive attitude to life, were consistent in achieving the goal and generally satisfied with the standard of living. The group mean of general mood indicator corresponded to a high score.

Table 2. Changes in the group means of the psychological state indicators of middle-aged women over seven months of 2020 (n=48)

Parameter	Values on 01.03.2020		Values on 01.10.2020		CI	p
	M	SD	M	SD		
Zest for life, points	7.3	0.51	4.6	0.74	0.4	<0.05
Resolution and fortitude, points	6.5	0.32	2.3	0.55	0.3	<0.05
Congruence between desired and achieved goals, points	7.1	0.28	3.5	0.12	0.1	<0.05
Self-concept, points	6.2	0.67	5.9	1.62	0.6	>0.05
Mood tone, points	7.1	0.17	4.3	0.97	0.4	<0.05

The greatest negative changes were observed in the items related to consistency, determination, resolution and a clear focus to achieve the goals. The obtained low scores indicate a passive perception and acceptance of own failures, as well as weakness and a lack of ability to achieve the planned goals. The zest for life and mood tone were found to significantly decrease ($p<0.05$) in women due to self-isolation. The only factor that remained almost unchanged was a positive self-concept.

The next stage of the study was to assess the structure of the relationships between morphological and psychological parameters of women during self-isolation. The results of this assessment are presented in table 3.

Table 3. Correlations between the morphological and psychological parameters in middle-aged women (n=48)

No	BW, kg	BMI	Abdomen circumfe-rence, cm	Hip circumfe-rence, cm	WHTR, arb.un.	WHR, arb.un.	Waist circumfe-rence, cm	Fat mass, %
1	-0.614***	-0.321*	-0.502**	-0.321*	-0.435**	-0.478**	-0.392*	-0.406**
2	-0.683***	-0.546***	-0.506**	-0.346*	-0.316*	-0.370*	-0.634***	-0.327*
3	-0.574***	-0.542***	-0.362*	-0.470**	-0.417**	-0.529***	-0.383*	-0.439**
4	-0.394*	-0.017	-0.427**	-0.070	-0.061	-0.577***	-0.086	-0.128
5	-0.520***	-0.375*	-0.424**	-0.395*	-0.537***	-0.458**	-0.371*	-0.358*

Notes: 1 – zest for life, points; 2 – resolution and fortitude, points; 3 – congruence between desired and achieved goals, points; 4 – self-concept, points; 5 – mood tone, points.

* – correlation coefficient is statistically significant at $p<0.05$; ** – correlation coefficient is statistically significant at $p<0.01$; *** – correlation coefficient is statistically significant at $p<0.001$.

The results of the correlation analysis indicated a large number of close inverse correlations between the psychological state of women and measurements of physique and their derived indices. Thus, body weight and abdomen circumference demonstrated significant moderate and strong inverse correlations (r from -0.362 at $p<0.05$ to -0.683 at $p<0.001$) with all items included in the questionnaire of the life satisfaction index. In summary, the above results show that overweight middle-aged women were in a negative mental state during the period of quarantine restrictions.

Discussion

Being overweight and obese is a major risk factor for deterioration of metabolic health, which may be manifested as dyslipidemia and insulin resistance, as well as for various respiratory dysfunctions that increase the risk of developing pneumonia (Mazur et al., 2020; Jun Yang et al., 2020). Some authors consider overweight and obesity to be an underestimated risk factor for COVID-19 that contributes to the onset of the disease at an earlier age (Kass et al., 2020). A significant association between increased BMI and complicated COVID-19 has been demonstrated (Tara et al., 2020). The data of our study confirm previous findings (Moroz, 2011) on weight gain and an increase in body surface area and waist circumference in adult-aged women that is characteristic of abdominal obesity.

Our study confirmed previous findings that ***the time-course of inactivity-induced metabolic dysfunction appears to be far quicker than the positive impact of increasing*** physical activity levels. It has been reported that physical inactivity, particularly during COVID-19 pandemic, can lead to an increase in the proportion of women with abdominal obesity and decreased muscle mass (Thyfault et al., 2011; Narici et al., 2020). This is undoubtedly a matter of serious concern under current conditions of social distancing and isolation, which is likely to last for several months, especially in relation to those who are more susceptible to illness due to impaired metabolic and physiological fitness.

The importance of adherence to regular physical activity including aerobic and anaerobic exercises during a long stay at home due to quarantine limitations has been emphasized by many authors (Bentlage et al., 2020; Chen et al., 2020; Dunton et al., 2020; Godefroy, 2020; Kaur et al., 2020; Polero et al., 2021). The benefits of physical activity and exercise across the lifespan have been demonstrated by many studies (Chtourou et al., 2020; de Oliveira Neto et al., 2020; Lavie et al., 2019). Being physically active during the coronavirus (COVID-19) outbreak is very important for physical and mental health (Hawryluck et al., 2004; Jiménez-Pavón et al., 2020). The findings of our study are consistent with a range of studies that have reported psychological health issues due to the COVID-19 pandemic and subsequent lockdown (Hawryluck et al., 2004; Ammar et al., 2021; Chtourou et al., 2020; de Oliveira Neto et al., 2020; Shigemura et al., 2020; Varshney et al., 2020). The results of this study are consistent with a number of other studies that have reported mental health issues as a result of the COVID-19 pandemic and subsequent social isolation (Hawryluck et al., 2004; Ammar et al., 2021; Chtourou et al., 2020; Clemente-Suárez et al., 2020; de Oliveira Neto et al., 2020; Varshney et al., 2020). Regular physical activity can enhance mood, wellbeing and energy levels by helping to reduce stress, anxiety and depression (Ammar et al., 2021; Andrieieva et al., 2019). There is evidence of a further decline in physical activity since the start of the pandemic for people with chronic conditions such as obesity and hypertension; conditions associated with worse outcomes from COVID-19.

Conclusions

Analysis of the data revealed significant negative changes in indicators of morpho-functional and psychological state of women occurred over seven-month period of restrictive quarantine. A significant deterioration was found in the functional capabilities of the body of women. A statistically significant ($p<0.05$) increase was identified in the group mean of the coefficient of endurance, resting heart rate, systolic blood pressure, and respiratory rate. The obtained results indicate an impairment of compensatory mechanisms in overweight and obese women. Indicators of psychological state underwent negative changes, too. Most negative correlations were found between psychological parameters and body weight, abdomen and waist circumferences, and derived indices. Sedentary lifestyle and emotional stress induced by fear of COVID-19 infection in women with overweight and obesity caused significant abnormalities in the function of the cardiovascular and respiratory systems.

Further research will focus on the development of practical guidelines for self-exercises of women under conditions of quarantine restrictions due to COVID-19 pandemics. Regular physical exercise will be aimed at improving physical health and eliminating depression.

Conflicts of Interest – All the authors declare to have no conflict of interest.

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