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Identification of Informative Physical Condition Indicators for Self-Training Exercise Programs Design for Middle-Aged Overweight and Obese Women

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Abstract

The objective of this study was to identify informative anthropometric and functional indicators for designing self-training exercise programs for middle-aged obese women. The study involved 105 women with an average age of 38.9 and was conducted at the Scientific Research Institute of NUPESU. The physical fitness profile of the middle-aged overweight and obese women was assessed by use of factor analysis. The dominant factor was the anthropometric status (42.1% of the total variance) and included 14 indicators. The second factor (21.2% of the total variance) included ten indicators characterising functional state of the cardiorespiratory system. The third and fourth factors (18.1% of the total variance) included eight indicators characterising physical fitness and coordination abilities. Five indicators were selected based on the factor analysis: waist circumference, abdominal circumference, waist to hip circumference ratio, adaptation potential, and VO_2max. Correlation analysis performed to verify the informative value of the selected markers showed that the waist circumference significantly correlated with 28 studied indicators; the abdominal circumference correlated with 29 indicators; the waist to hip circumference ratio correlated with 24 indicators of physical condition; the adaptation potential correlated with 24 indicators; and VO_2max significantly correlated with 18 indicators. Informative markers selected based on the factor and correlation analyses can be used for designing and assessing the effectiveness of physical exercise programs for middle-aged overweight and obese women.

Keywords: *exercise, overweight, obesity, physical conditions, middle-aged women*

Introduction

There is a growing interest in self-dependent physical exercise among middle-aged women due to body weight gain and the tangible consequences of age-related involution processes (Mazur, 2020). It has been found that body weight gain in women over 35 years of age is caused by a decrease in physical activity (Nagornaya, & Andreeva, 2018). The age of 46-55 is characterised by significant hormonal changes in a woman's body, which along with a decrease in general morpho-functional status often lead to a disruption of adaptive processes and a steady deterioration of health condition (Garmash, 2017). After the age of 45, there is a significant deterioration in

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physical performance, motor skills, dynamic balance, lumbar spine mobility, etc. Each subsequent five years of life are characterised by an increase in the number of people with stress and disruption of cardiovascular adaptation (Ruiz-Montero, & Castillo-Rodríguez, 2016).

Researchers have noted that excessive physical exercise without appropriate monitoring can bring about a negative effect (Galan et al., 2020; Kashuba et al., 2020; Quindry, Williamson-Reisdorph, & French, 2020). This is the main risk when it comes to organizing self-training exercise among the population. It is known that the optimal effect of physical exercise can be achieved only when the focus, intensity, volume, and frequency of physical activity are selected individually, taking into account the level of the trainee's physical condition. In this regard, it is of paramount importance to use correct methods for assessing, monitoring, and self-monitoring of physical development and health status when designing self-training health-improving activities for middle-aged women targeted to manage body weight (Lazareva, Aravitska, Andrieieva, Galan, & Dotsyuk, 2017). Thus, it is relevant to determine informative criteria that can be used to assess the effectiveness of exercise programs for middle-aged obese women.

The objective of this study was to identify informative anthropometric and functional indicators for designing self-training exercise programs for middle-aged overweight and obese women.

Methods

The study was conducted in 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 25 and 45, overweight and obese (the Body Mass Index (BMI) from 25.00 to 32.10 kg/m^2), 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. At the beginning of the study, women were inactive and led a sedentary lifestyle.

Anthropometric methods that ensured quantitative measurement of physical development indicators were used in compliance with international standards. Body Mass Index (BMI) was calculated by the formula: BMI=Body weight (kg) / Body height (m)2. The waist-to-height ratio (WHtR) was calculated by the formula: WHTR=Waist circumference (cm) / Body height (cm). The waist-to-hip ratio (WHR) was calculated by the formula: WHR=Waist circumference (cm) / Hip circumference (cm). Body composition was assessed using a body composition analyzer Tanita (Tanita Europe GmbH, Japan). To assess the cardiorespiratory system, physiological methods were used. Measurements were performed using a digital blood pressure and heart rate monitor UA 767 (AND, Japan). Heart rate (HR) was assessed using Polar RS800G3 (Finland) and Garmin Forerunner 305 heart rate monitors. Oxygen saturation was measured using a Beurer PO 80 pulse oximeter (Germany). To assess the level of physical fitness and to determine maximum oxygen uptake (VO_2max), aerobic and anaerobic thresholds, a cardiorespiratory test (Hanson, 1984) was performed on a treadmill LE-200 CE (Jaeger, Germany). During the cardiorespiratory exercise test, the following conditions were applied: for women with BMI≤30 kg/m-², initial speed and incline were 5 km/h and 0%, speed and incline were increased by 1 km/h and 0.5%, respectively, and after reaching the speed of 20 km/h, only incline were increased; for women with BMI≥30 kgm-², initial speed and incline were 4 km/h and 0%, incline were increased by 1%. The adaptation potential (AP) of the cardiovascular system was calculated using the Bayevsky's method (Bayevsky, Berseniyeva, & Paleyev, 2001) by the formula:

AP=0.011×HR+0.014×BPsyst+0.008×BPdiast+0.009×Body weight(kg)+0.0014×age(years)-0.009×Body height (cm)-0.27.

The index of physical condition (IPC) of the body was calculated by the Pirogova (1989) as follows:

IPC = (700-3×HR-2.5×BPav-2.7×age+0.28×Body weight)/(350-2.6×age+0.21×Body height)

The Oxycon Pro Ergospirometry System (USA) was used to determine the lung vital capacity (VC). Physical fitness testing included performing several motor tests from the Eurofit battery (Adam, 1988). The results of the study were analysed using conventional tools of Statistica 10.0 statistical software (StatSoft, Inc., USA). The statistical analysis of experimental data was started with the verification of the assumption of normality using the Shapiro-Wilk test. Factor analysis was used in the study as an independent research method. To measure the strength of the relationships between normally distributed variables, correlation analysis was used. Since the analysis of correlation fields showed the presence of linear relationship, we used the Pearson correlation coefficient.

Results

To identify the major factors, which determine the structure of physical condition in middle-aged obese women, and to select the most informative criteria for designing self-training exercise programs, we used factor analysis (Table 1). Calculations yielded a four-factor structure, which explains 81.4% of the variance of the initial data.

Factor I contributed 42.1% to the total sample variance and identified 14 indicators of physique. With direct weighting factors, the following indicators were included: inspiratory chest circumference (CC) ($r=0.875$ at $p<0.01$), expiratory CC ($r=0.848$ at $p<0.01$), muscle mass percentage ($r=0.777$ at $p<0.01$), chest excursion ($r=0.768$ at $p<0.01$), and basal metabolic rate ($r=0.711$ at $p<0.01$). Using inverse weighting factors, the following indicators were included: abdomen circumference ($r=-0.927$ at $p<0.01$), waist circumference ($r=-0.926$ at $p<0.01$), WHR ($r=-0.922$ at $p<0.01$), CC ($r=0.893$ at $p<0.01$), WHtR ($r=-0.884$ at $p<0.01$), BW ($r=-0.820$ at $p<0.01$), BMI ($r=-0.807$ at $p<0.01$), and hip circumference ($r=-0.732$ at $p<0.01$). The second factor contributed 21.2% to the total sample variance and identified ten indicators of the energy potential of aerobic function and functional state. Factor II revealed a statistically significant direct correlation with maximum oxygen uptake (VO_2max) ($r=0.945$ at $p<0.01$), vital capacity (VC) ($r=0.791$ at $p<0.01$), vital capacity-to-body weight ratio ($r=0.715$ at $p<0.01$), and index of physical condition (IPC) ($r=0.714$ at $p<0.01$). With inverse weighting factors, factor II included adaptive potential (AP) ($r=-0.936$ at $p<0.01$), HR recovery time after 20 squats ($r=-0.837$ at $p<0.01$), Robin-

Table 1. Factor loading matrix of physical condition variables of middle-aged obese women (n=105)

Parameter	F I	F II	F III	F IV
Body height, cm	0.111	-0.594	-0.038	0.027
Body weight, kg	**-0.820**	-0.186	-0.032	-0.116
BMI, kg·m^{-2}	**-0.807**	-0.228	-0.019	-0.043
CC, cm	**-0.893**	0.159	0.234	-0.106
Inspiratory CC, cm	**0.875**	0.095	0.210	-0.112
Expiratory CC, cm	**0.848**	0.180	0.201	-0.136
Chest excursion, cm	**0.768**	0.127	0.102	0.045
Waist circumference, cm	**-0.926**	-0.095	-0.073	-0.075
Abdomen circumference, cm	**-0.927**	-0.167	-0.296	-0.181
Hip circumference, cm	**-0.732**	-0.131	-0.299	-0.161
Waist-to-hip ratio (WHR), arb. units	**-0.922**	0.236	0.311	-0.012
The waist-to-height ratio (WHtR), arb. units	**-0.884**	-0.308	-0.090	-0.069
Grip strength (dominant hand), kg	-0.090	0.431	**-0.795**	0.435
Grip strength (non-dominant hand), kg	-0.032	0.384	**-0.782**	0.509
Fat mass, kg	-0.457	-0.321	-0.021	-0.116
Fat mass, %	**-0.800**	0.131	0.077	-0.007
Muscle mass, kg	0.178	0.324	0.369	0.019
Muscle mass, %	**0.777**	-0.189	-0.075	-0.091
Basal metabolic rate, kcal	**0.711**	-0.369	-0.037	0.097
Heart rate, bpm	0.286	**-0.812**	-0.164	0.003
BPsyst, mmHg	0.416	**-0.824**	0.087	0.495
BPdiast, mmHg	0.263	**-0.806**	-0.014	0.189
AP, arb. units	0.651	**-0.936**	-0.004	0.345
VC, mL	0.106	**0.791**	0.219	0.227
VO_2max, mL·kg·min^{-1}	0.339	**0.945**	0.110	0.544
Bayevsky's stress index, arb. units	-0.452	**-0.820**	-0.087	-0.107
Oxygen saturation, %	0.226	0.202	0.041	0.350
IPC, arb. units	0.213	**0.714**	0.107	0.136
Robinson index, arb. units	-0.413	**-0.832**	-0.081	0.242
Vital capacity-to-body weight ratio, mL·kg^{-1}	0.526	**0.715**	0.150	0.276
Strength index, arb. units	0.446	0.484	**0.785**	0.331
HR recovery time after 20 squats in 30 s, min	-0.121	**-0.837**	-0.213	-0.230
Sit and reach flexibility test, cm	0.218	0.082	0.412	0.367
Sit-up test for 30 s, number of reps	0.277	0.053	**0.771**	0.407
Static strength of the back muscles, s	0.239	0.032	**0.770**	0.463
Shuttle run test 10x5 m, s	-0.307	-0.160	**-0.798**	-0.540
Sharpened Romberg test, s	0.423	0.229	0.315	**0.777**
Flamingo test, number of reps	0.374	0.189	0.425	**0.741**
Total variance	**14.9**	**7.4**	**3.7**	**3.2**
D (F). %	**42.1**	**21.2**	**9.8**	**8.3**

Legend: FI-FIV – are the major factors, which determine the structure of physical condition in middle-aged obese women. Factor I is associated with physique; Factor II – with energy potential of aerobic function and functional state; Factor III – with endurance and strength; and Factor IV – with coordination abilities.

son index (r=-0.832 at p<0.01), systolic blood pressure (BP) (r=-0.824 at p<0.01), Bayevsky stress index (SI) (r=-0.820 at p<0.01), resting HR (r=-0.812 at p<0.01), and diastolic BP (r=-0.806 at p<0.01). Factor III contributed 9.8% to the total sample variance and identified six indicators of endurance and strength. The structure of this factor is based on indicators with high inverse correlations: 10×5m shuttle run test (r=-0.798 at p<0.01), grip strength (dominant hand) (r=-0.795 at p<0.01), and grip strength (nondominant hand) (r=-0.782 at p<0.01). Direct correlations with this factor included strength index (SI) (r=0.785 at p<0.01), sit-up test for 30 s (r=0.771 at p<0.01), and static strength of the back muscles (r=0.770 at p<0.01). Factor IV with a contribution of 8.3% to the total sample variance is based on indicators characterizing coordination abilities and has a statistically significant direct correlation with sharpened Romberg test (r=0.777 at p<0.01) and Flamingo test (r=0.741 at p<0.01).

Based on the use of multidimensional statistics, we found indicators that determine the physical fitness in middle-aged obese women: physique, aerobic performance, physical condition (endurance and strength), and coordination abilities. These results are consistent with the point of view that there is no single integral parameter that characterises the overall physical condition of an individual. We found that indicators of physique play an important role in the physical condition of middle-aged women (factor I). An anthropometric study is the most comprehensible method that allows evaluation of physique and identification of parameters that need correction. In comparison with other data, the group of variables characterizing the total body dimensions is distinguished by a large factorial weight that exceeds the value of all other indicators.

Furthermore, factor I indicators, such as VO_2max, AP, and recovery time after a dynamic load, have a significant factor load. This indicates the key role of these anthropometric and physiological variables for the structure of physical condition of obese women. The correlation structure of the selected indicators with the main components of physical condition was established to determine the effectiveness markers for health fitness program. The correlation coefficients between the selected indicators and factor I indicators are shown in Table 2. The correlation analysis indicated a clear direct relationship between the circumferences of the waist and abdomen, waist-to-hip ratio, and AP and almost all the physique indicators and body composition. Waist circumference has high direct correlations with BM, BMI, CC, inspiratory CC, expiratory CC, abdomen circumference, hip circumference, all body composition indicators, and basal metabolism. Correlation coefficients ranged from r=0.455 at p<0.001 to r=0.852 at p<0.001. A high inverse correlation was observed only for muscle mass percentage. Waist circumference did not correlate with body height (BH) or chest excursion. Similar high correlations were observed between the abdomen circumference and the indicators that are included in factor I. Both abdomen and waist circumferences have no correlation with BH or chest excursion. WHR has high and medium correlations with most indicators of physique and body composition.

Table 2. Correlation between the markers of physical condition and factor I indicators

Indicators of the factor I that characterise physical development	1	2	3	4	5
Body height, cm	0.161	0.099	-0.100	**0.321*****	-0.096
Body weight, kg	**0.811*****	**0.723*****	**0.371*****	**0.585*****	**-0.437*****
BMI, kg·m^{-2}	**0.724*****	**0.688*****	**0.436*****	**0.357*****	**-0.361*****
CC, cm	**0.818*****	**0.726*****	**0.625*****	**0.385*****	-0.177
Inspiratory CC, cm	**0.816*****	**0.715*****	**0.610*****	**0.397*****	-0.194
Expiratory CC, cm	**0.768*****	**0.688*****	**0.596*****	**0.353*****	**-0.207*****
Chest excursion, cm	0.013	-0.028	-0.048	0.061	0.063
Waist circumference, cm	**1.000**	**0.852*****	**0.792*****	**0.545*****	**-0.282****
Abdomen circumference, cm	**0.852*****	**1.000**	**0.533*****	**0.501*****	**-0.337*****
Hip circumference, cm	**0.622*****	**0.728*****	**0.217***	**0.511*****	**-0.281****
Fat mass, kg	**0.443*****	**0.401*****	**0.226***	**0.466*****	-0.136
Fat mass, %	**0.656*****	**0.691*****	**0.367*****	**0.412*****	**-0.239***
Muscle mass, kg	**0.489*****	**0.356*****	**0.257****	**0.379*****	**-0.211***
Muscle mass, %	**-0.630*****	**-0.696*****	**-0.380*****	**-0.418*****	0.089
Basal metabolic rate, kcal	**0.455*****	**0.331*****	**0.274****	**0.466*****	-0.184

Legend: 1 – waist circumference, cm; 2 – abdomen circumference, cm; 3 –WHR, arb. units; 4 – AP, arb. units; 5 – VO_2max, mL·kg·min^{-1}. n=105; rcr=0.195; r=-0.207 at p<0.05; r=0.257 at p<0.01; r=0.321 at p<0.001. * – correlation coefficient is statistically significant at the p<0.05 level; ** – correlation coefficient is statistically significant at the p<0.05 level; *** – correlation coefficient is statistically significant at the p<0.001 level.

AP values in middle-aged women were also reliably correlated with almost all indicators that were included in factor I. AP is an integral estimate indicator that considers six indicators: three of them characterise the cardiovascular system and the rest take into account anthropometric data and age. This indicator enables the evaluation of individual's adaptive responses. AP had no correlation with chest excursion. AP had an inverse relationship with muscle mass percentage. The correlation coefficients between AP and BM, BMI, CC, inspiratory CC, expiratory CC, abdomen circumference, hip circumference, all body composition indicators, and basal metabolism ranged from r=0.327 at p<0.001 to r=0.585 at p<0.001. This can be explained by the fact that the AP level depends on the parameters of physique and body composition. VO_2max is another indicator that was selected as an effectiveness marker. This indicator had high and medium inverse correlations with BM, BMI, abdomen circumference, fat mass percentage, waist circumference, and hip circumference with correlation coefficients ranged from r=-0.281 at p<0.01 to r=-0.437 at p<0.001. Overweight and abdominal obesity adversely affect aerobic performance. There were several correlations between the indicators included in factor II that reflect the state of functional systems and indicators selected as effectiveness markers (Table 3); the correlations were mainly between directly measured indicators and indicators derived from them.

Table 3. Correlation between the markers of physical condition and factor II indicators

Indicators of the factor II that characterize functional state and aerobic performance of the body	1	2	3	4	5
BP_{syst}, mmHg	**0.483*** **	**0.403*** **	**0.201***	**0.892*** **	**-0.363*** **
BP_{diast}, mm Hg	**0.246***	**0.213***	**0.310** **	**0.641*** **	**-0.341*** **
Heart rate, bpm	**0.231***	**0.234***	**0.203***	**0.683*** **	**-0.214***
VC, mL	**-0.203***	-0.166	**-0.422*** **	0.134	**0.229***
HR recovery time after 20 squats in 30 s, min	**0.210***	**0.242***	0.139	**0.299***	**-0.453*** **
Oxygen saturation, %	-0.130	**-0.211***	0.094	-0.075	0.156
Vital capacity-to-body weight ratio, mL·kg^{-1}	**-0.629*** **	**-0.552*** **	**-0.546*** **	**-0.238***	0.052
IPC, arb. units	**-0.384*** **	**-0.332*** **	-0.115	**-0.902*** **	**0.282** **
Robinson index, arb. units	**-0.402*** **	**-0.365*** **	-0.045	**0.900*** **	-0.187
Bayevsky stress index, arb. units	**0.244***	**0.283** **	0.087	**0.343*** **	-0.100
AP, arb. units	0.645***	0.567***	0.261**	1.000	-0.219*

Legend: 1 – waist circumference, cm; 2 – abdomen circumference, cm; 3 –WHR, arb. units; 4 – AP, arb. units; 5 – VO_2max, mL·kg·min^{-1}. n=105; r_{cr}=0.195; r=0.201 at p<0.05; r=0.261 at p<0.01; r=-0.332 at p<0.001. * – correlation coefficient is statistically significant at the p<0.05 level; ** – correlation coefficient is statistically significant at the p<0.05 level; *** – correlation coefficient is statistically significant at the p<0.001 level.

Waist and abdomen circumferences directly associated with systolic and diastolic BP, resting HR, HR recovery time after 20 squats in 30 s, stress index, and AP. Overall, the absolute values of the above indicators immediately increased with an increase in the circumference body dimensions, which adversely affect the cardiovascular system. Reverse correlations were observed between waist circumference, VC, vital capacity-to-body weight ratio, IPC, and Robinson's index. Correlation coefficients ranged from r=-0.203 at p<0.05 to r=-0.629 at p<0.001. Similar inverse correlations were observed between abdomen circumference and oxygen saturation, vital capacity-to-body weight ratio, IPC, and Robinson's index. In women aged 36-45, the indicators characterizing the external respiration system, the oxygen transport system, and adaptation potential of the body significantly decreased with an increase in waist and abdomen circumferences. WHR had a much lower correlation with the indicators that were included in factor II. High inverse correlations were observed with VC and vital capacity-to-body weight ratio at the levels of r=-0.422 at p<0.001 and r=-0.546 at p<0.001, respectively.

The direct dependence of WHR on systolic and diastolic BP, resting HR, and AP indicated a negative effect of obesity on cardiovascular fitness. It is known that the risk of developing high BP in obese people is three times higher than in people with a normal body weight. According to the INTERSALT study, there is an increase in systolic BP by 4.5 mm Hg for every 4.5 kg of weight gain.

The VO_2max showed high inverse correlations with the indicators for resting condition, namely, systolic BP at r=-0.363 at p<0.001, diastolic BP at r=-0.341 at p<0.001, and HR recovery time after 20 squats within 30 s at r=-0.453 at p<0.001. There was also an inverse correlation with resting HR and AP. The VO_2max in middle-aged obese women directly depended upon VC and IPC. VO_2max depends primarily on the capabilities of the cardiorespiratory system. Our findings are consistent with the scientific statement from the American Heart Association recommending that cardiorespiratory fitness, quantifiable as VO_2max, be regularly assessed and used as a clinical vital sign. The coeffi-

Table 4. Correlation between the markers of physical condition and factors III and IV indicators

Indicators of the factors III and IV that characterize physical fitness	1	2	3	4	5
Static strength of the back muscles, s	-0.225*	-0.327***	-0.072	-0.147	0.768***
Sit-up test for 30 s, number of reps	-0.283**	-0.325***	-0.227*	-0.124	0.523***
Grip strength (dominant hand), kg	-0.010	-0.298*	-0.249*	-0.106	-0.064
Grip strength (non-dominant hand), kg	0.083	-0.388***	-0.157	-0.005	-0.056
Strength index, arb. units	-0.449***	-0.131	-0.364***	-0.455***	0.107
Shuttle run test 10x5 m, s	-0.285**	-0.322***	0.096	0.222*	-0.872***
Sharpened Romberg test, s	-0.390***	-0.286**	-0.249*	-0.091	0.152
Flamingo test, number of reps	0.355***	0.229*	0.233*	0.109	-0.088

Legend: 1 – waist circumference, cm; 2 – abdomen circumference, cm; 3 –WHR, arb. units; 4 – AP, arb. units; 5 – VO_2max, mL·kg·min^{-1}. n=105; r_{cr}=0.195; r=0.222 at p<0.05; r=0.283 at p<0.01; r=-0.322 at p<0.001. * – correlation coefficient is statistically significant at the p<0.05 level; ** – correlation coefficient is statistically significant at the p<0.05 level; *** – correlation coefficient is statistically significant at the p<0.001 level cients of correlation of the selected markers with the indicators included in factors III and IV are shown in Table 4. There was a small number of significant correlations between the indicators characterizing physical fitness and selected indicators.

The static strength of back muscles and the strength of abdominal muscles in middle-aged women directly correlated with VO_2max and inversely correlated with waist and abdomen circumferences. This can be explained by the fact that overweight leads to a decrease in both static and dynamic endurance. The results of the grip strength test for dominant and non-dominant hands had an inverse correlation with abdomen circumference, indicating that overweight and obesity are the main factors that reduce muscle strength. The results of shuttle run test showed inverse correlations with the waist and abdomen circumferences, and VO_2max and a direct correlation with AP. Coordination abilities also significantly depended on waist and abdomen circumferences and WHR. These findings suggest that overweight and obesity lead to inaccuracy in movements and adversely affect the functions of balance and static endurance. The results of the correlation analysis indicated that the overwhelming majority of indicators of physical condition and coordination abilities depend on the waist and abdomen circumference and VO_2max. The absence of correlations with AP can be explained by the fact that this is an estimate indicator, which is inappropriate to use as an efficiency criterion when analysing physical condition.

Discussion

Body weight is an important indicator of a person's physical health (World Health Organization, 2016; Wiklund, 2016). Overweight causes an increased risk of disease (Van Gaal, & Maggioni, 2014; Sairenchi, Iso, Yamagishi, & Irie, 2017). It was reported that BMI does not always provide comprehensive information on the risk of morbidity associated with excess weight (Moroz, 2011, Runenko, Razina, Shelekhova, & Mushkabarov, 2018). It does not reflect the individual characteristics of body composition, the changes in which often precede the increase in total weight and have a negative impact on the cardiorespiratory performance of a person (Lamarche, Notley, Poirier, & Kenny, 2017). Statistics indicate that women are more prone to being overweight: overweight is 1.7 times more common among women than among men (Nagorna & Andrieieva, 2018). Several studies have highlighted the particular dangers of being overweight to women's health (Peeters, Dobson, Deeg, & Brown, 2013; Maslyak, 2015). The issue of designing preventive and health-improving exercise programs for adults, including middle-aged women has been widely discussed in scientific literature (Moroz, 2011) along with the issue of overweight (Bilyak, 2012; Nagorna, 2018; Drapkina, Kupreyshvili, & Fomin, 2017). However, the issue of managing overweight in middle-aged women remains insufficiently substantiated (Erakova, 2017; Neto, de Walsh, & Bertoncello, 2020). Recommendations on the type and optimal modes of exercise training that has been developed to normalize body weight are mainly imperfect and fragmentary (Beqa, Elezi, & Elezi, 2019; Chen, Ismail, & Al-Safie, 2016; Drozdovska, Andrieieva, Yarmak, & Blagii, 2020). There is a lack of substantiated criteria for the effectiveness of health-improving programs for this population. Increased attention to the dosage of exercise for overweight people is associated with the predominant use of self-training exercise, which lack consistent monitoring from a trainer or physician (Drozdovska et al., 2020). Therefore, the opportunities of applying self-training exercise should be based on precise recommendations for assessing both the physical condition and the parameters of training loads. In this study, we have identified the most significant factors in the structure of the physical condition of overweight women. The factor structure of the physical condition of people of different age groups has been investigated by many authors (Andrieieva et al., 2020; Galan, Andrieieva, Yarmak, & Shestobuz, 2019). The effectiveness of this approach has been reported in a number of studies (Ostojic et al., 2011; Gurieieva & Klopov, 2014; Yarmak et al., 2019). We confirmed the previously reported data (Güler, Yüksek, & Göksu, 2020; Paliichuk et al., 2018) on the relationship between overweight and the functional state of the body. The tolerance of the cardiovascular system to exercise loads depends on the fat mass even more than on the value of BMI (Moroz, 2012). In persons with abnormal morphological status, it does not exceed 65% of VO_2max (Belyak, 2012). Our findings confirm the data on the significance of the VO_2max in the structure of women's physical condition (Justine, Ishak, & Manaf, 2018). The validity of this conclusion is also confirmed by the results of earlier studies (Peeters et al., 2013).

Our study extended previous findings on the relationship between the parameters of body weight and the indicators of physical health in women, as well as on the multifactorial etiology of body weight disorders that necessitate the use of comprehensive health-improving programs for its correction. We also confirmed high informativeness of morphological parameters for predicting disease risk. This study extended our knowledge on the relationships between the physique and physical fitness of overweight women and substantiate the appropriateness of the use of exercise training in programs for preventing overweight (Andrieieva et al., 2019; Kashuba et al., 2019). We demonstrated the appropriateness of using the identified markers for designing health-improving programs for middle-aged women. It was demonstrated that proper monitoring over the identified markers of physical condition in the course of exercise training can increase the safety and effectiveness of health-improving activities.

Conclusion

Informative markers selected in this study based on the factor and correlation analyses can be used for designing and assessing the effectiveness of physical exercise programs for middle-aged overweight and obese women.

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Conflict of Interest
The authors declare that there are no conflicts of interest.

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