

Physical activity for prevention and correction of postural abnormalities in young women

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Abstract.

The aim of the study was to assess the impact of physical activity on the prevention and treatment of postural abnormalities in young women. In this study, the following methods were used: sociological methods; pedagogical observation; pedagogical experiment; pedagogical testing; anthropometrics; measurement of muscular strength using the Back Check 607 system; video recording and biomechanical analysis of biogeometrical profile of the individual's posture (using the Torso software), methods of mathematical statistics. The study involved 94 women aged 22 to 24 years. Results: Most of the women had various postural abnormalities, and only 25% of the subjects had normal posture. The program for the correction of postural disorders was developed involving the means of health-enhancing physical activity. One-year participation in the program contributed to the improvement in the parameters of physical development and physical fitness of women as well as correction of postural abnormalities in the frontal plane.

Keywords: physical activity, prevention, correction, postural abnormalities, young women, program of physical exercise.

Introduction

Maintaining and improving women's health is one of the most pressing problems of our time (Bibik, 2010; Kashuba, 2017). The resolution of this problem can contribute to achievement of social, demographic and cultural objectives of society. In the Ukrainian society, the potential of physical activity to maintain a healthy lifestyle and improve the health of population, to prevent unhealthy habits and address other important socio-economic issues is underestimated due to a number of objective and subjective reasons (Drzał-Grabiec, 2013; Lazarevaetal, 2017). Physical exercise is an effective way to prevent and manage many diseases, in particular, disorders of the musculoskeletal system (Andrieieva, 2017a; Lazarevaetal, 2017). The data of studies (Drzał-Grabiec, 2014; Kashuba, 2016a; Fomenko, 2015;) indicated a high prevalence of postural abnormalities among young women. There is an urgent need for including health-enhancing physical activity into technologies for correcting functional disorders of the musculoskeletal system (Kashuba, 2016b, Yarmak, 2017b). A number of studies have been undertaken so far in this area of research. Cruz-Ferreira A. (2013) developed a technique involving health-enhancing gymnastic exercises for correcting deformities of the spine in early adulthood. Drzał-Grabiec(2014) theoretically grounded, classified, and tested aerobic exercise for correcting structural and functional abnormalities of the spine. Kukoba T.B. (2011) developed a methodology for correcting the disorders of the musculoskeletal system in 21-35 year-old women through the use of health-enhancing training with isotonic exercises which implements a differentiated approach taking into account the patient's somatotype. R. Bibyk (2013) developed a technology for correcting the postural abnormalities in adult women involving fitball aerobics exercises.

All of the above suggests the need for scientific grounding and development of the technology for correction of postural abnormalities in women in early adulthood that involves health-enhancing physical exercise. The relevance of the problem, its great social significance guided the choice of the topic for the study and determined its aim and objectives. A precondition for the development of postural abnormalities is the weakness of the muscles that stabilize the spine. The most common reason for a weak back is reduced physical activity and insufficient physical exercise, which contribute to the formation of the muscular core of the body.

Material and Methods

At the first stage, the study involved 94 women aged 22-24 years. At the second stage, the pedagogical experiment involved 33 women aged 22-24 years with postural abnormalities in the frontal plane (the scoliotic posture). Control group (CG) consisted of 17 subjects and experimental group (EG) involved 16 women. Women who belonged to the groups at the beginning of the experiment did not have a statistically significant difference in the parameters ($p > 0.05$) that were studied. The protocols of experiments were approved by the ethics commission of the National University of Physical Education and Sport of Ukraine. According to ethical standards, all participants voluntarily provided written informed consent for participation in all stages of the pedagogical experiment, for further analysis and disclosure of their personal data during interpretation and publication of the results of the study.

The following methods were used: analysis of scientific and methodological literature; sociological methods (assessing the motivation of women to the participation in health-enhancing fitness classes); pedagogical observation (review of more than 500 health-enhancing fitness classes); pedagogical experiment (ascertaining experiment and formative experiment were conducted); pedagogical experiment (the experiment included the assessment of the static strength endurance of the spinal erectors, the static strength endurance of the gluteal and spinal muscles, the strength endurance of the abdominal muscles, the flexibility of the spine, range of motion of the hip joints, hamstring elasticity, and static body balance); anthropometrics; measurement of muscular strength using the Back Check 607 system; video recording and biomechanical analysis of biogeometrical profile of the individual's posture (using the Torso software).

Statistical analysis of the data was calculated using Microsoft Excel 2010 data analysis tool. The significance of the differences between the variables of the groups that followed a normal distribution, was assessed using the Student t-test. Statistical significance was considered for p -values ≤ 0.05 . First, descriptive statistics of all variables were calculated (mean and standard deviation). Kolmogorov-Smirnov and χ^2 test were used to assess the normality of the data distribution. Then, a non-parametric test was used to determine the effects of the program and Mann-Whitney U was used to determine the influence of the program. The statistical data treatment was carried out with SPSS 22.0.

Results

The study revealed the following functional disorders of the musculoskeletal system in young women: the scoliotic posture was found in 35.11 % of women ($n = 33$), the round back posture was in 21.28% of subjects ($n = 20$), the round hollow back posture was in 11.70 % ($n = 11$), and the flat back posture was in 6.38% of women ($n = 6$) (Fig. 1).

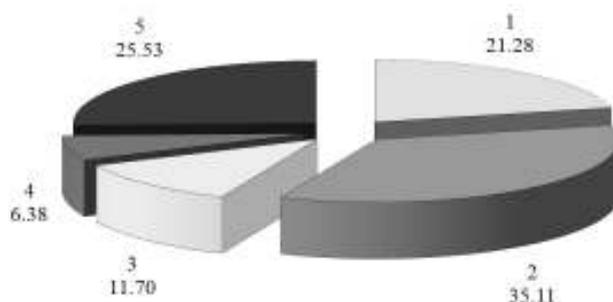


Fig. 1. Distribution of different posture types among the women involved in the study (%): 1 – the round back posture; 2 – scoliotic posture; 3 – the round hollow back posture; 4 – the flat back posture; 5 – normal posture.

An analysis of anthropometric data of women with different posture types revealed the significant differences ($p < 0.05$) between the physical development of women with normal posture and those with various postural abnormalities. Posture misalignments, both in sagittal and in the frontal plane, affect the strength topography of the skeletal muscles in young women.

The results of the tests assessing the static strength endurance of the muscles, the flexibility of the spine, range of motion of the hip joints, and hamstring elasticity, as well as the static equilibrium of women with normal posture differed significantly from women with postural abnormalities ($p < 0.05$). On the basis of the obtained results, the general structure and the content of the annual program of health-enhancing fitness classes for young women were developed. The developed program was aimed at the following objectives:

- correction of posture misalignments in the frontal plane;
- normalization of muscle tone of the right and left sides of the trunk;
- increase in strength of the muscles involved in maintenance of the orthograde posture;
- improvement in balancing abilities;

- shaping and maintenance of habits of proper posture;
- training in the skills of doing special exercises in unloading initial positions aimed at the development and maintenance of strength endurance of the trunk muscles;
- formation of the need for exercising regularly at home to implement individual health-enhancing program in the period between workouts.

The developed program consisted of preparatory, main, and maintaining stages. The preparatory stage was focused on identifying the types of posture misalignments of the participants of the study and assessing their physical condition.

The main stage was aimed at correction of postural abnormalities, strengthening of the core muscles, changing muscle topography, formation of the static/dynamic pattern, increasing the level of physical fitness of participants due to the reduction of the cardiovascular disease risk factors, and increasing the resistance of the body to adverse environmental factors. The maintaining stage was focused on the maintenance of the improved posture and achieved level of physical fitness. To address the objectives of the fitness classes, the special static/dynamic exercises were used in combination with breathing exercises in various initial positions; strength exercises contributing to strengthening the muscular system; special corrective exercises, which combine generation of muscle contractions with further relaxation and stretching; exercises focused on improving coordination of movements and development of stability of the body in the standing position; special exercises combined with dynamic and static short-term muscle contractions; relaxation breathing exercises; and isometric exercises. The workouts lasted for 60 minutes and were done three times a week. The classes included basic aerobic gymnastics elements, dance combinations, exercises on a fitball, free weight exercises, yoga elements, breathing exercises, and stretching. The ratio of the means of general and specific training for aerobic exercises was 60% / 40%. Training heart rate zone was 130-150 beats per minute for aerobic exercises and 110-129 beats per minute for recovery exercises. Training intensity was 50-75 % of VO_{2max} for aerobic exercises and 12-14 RM or 10-12 points on the Borg scale for resistance exercise. The program included mainly aerobic exercises (75% of the total class time), there were no intervals of high intensity exercise.

The building block concept was used to develop the general structure of health-enhancing fitness classes. The general structure of the classes consisted of 5 blocks, which had different targeted focuses: warm-up, aerobic, corrective/preventive, stretching, and warm-down (Fig. 2).

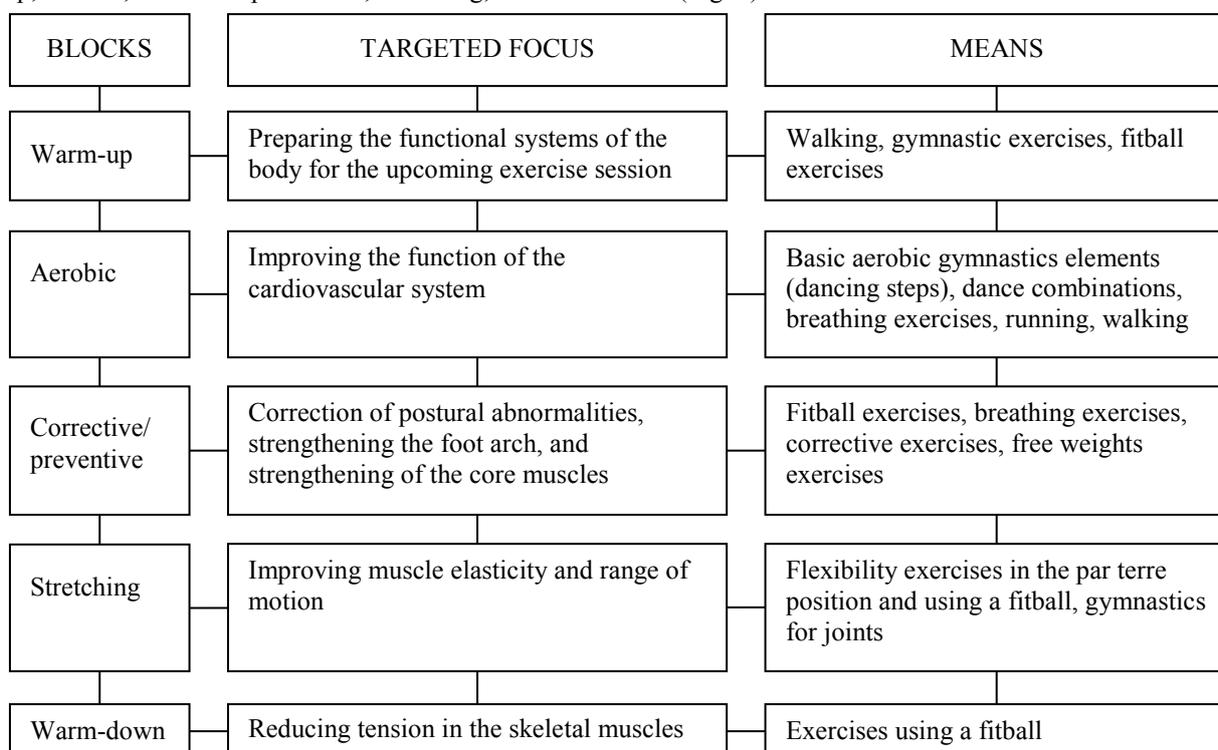


Fig. 2. Structure and targeted focus of health enhancing fitness classes

A comparative pedagogical experiment was conducted to determine the effectiveness of the proposed program. The women of the control group (CG) (n = 17) and of the experimental group (EG) (n = 16) had posture misalignments in the frontal plane (scoliotic posture). Study participants were randomly assigned to the groups in such a way, that the groups did not differ significantly in the studied parameters ($p > 0.05$). The pedagogical experiment lasted for one year.

After the experiment, the parameters of physical condition and physical fitness of women were changed both in the EG and the CG. It should be noted that the parameters of the EG were statistically significantly higher compared to the CG ($p < 0.05$) according to the Mann-Whitney test.

Somatoscopic studies and comparisons found the improvements in posture of women of the EG: the scapular balance angle decreased on average from 5.0° ($S = 1.1^\circ$) to 2.9° ($S = 0.5^\circ$) ($p < 0.05$). In women of the CG, no significant positive changes were observed for this parameter ($p > 0.05$); the same trend was also observed for the biacromial angle (Fig. 2).

Table. Morphofunctional parameters of women in early adulthood
at the end of the formative experiment (n=33)

Parameter	Control group (n = 17)				p	Experimental group (n = 16)				p
	before the study		after the study			before the study		after the study		
	\bar{x}	S	\bar{x}	S		\bar{x}	S	\bar{x}	S	
The biacromial angle (the angle of inclination of the line passing through the right and the left acromions (α_1), degrees	4.6	1.1	3.9	1.1	$p > 0.05$	4.4	1.2	2.6	0.5	$p < 0.05$
The scapular balance angle (the angle of inclination of the line passing through the right and left inferior scapular angles (α_2), degrees	5.3	1.1	4.6	1.0	$p > 0.05$	5.0	1.1	2.9	0.5	$p < 0.05$
Strength endurance of the abdominal muscles: maintenance of the trunk in the inclined position at an angle of 45° relative to the floor, hands along the trunk, reach forward with hands, s	35.8	1.0	37.3	1.5	$p < 0.05$	36.3	1.0	40.8	3.6	$p < 0.05$
Cooper's 12 minute run test, m	1444.1	222.1	1617.6	123.7	$p < 0.05$	1509.4	180.9	1793.8	112.4	$p < 0.05$
Strength endurance of the spinal erectors, s	36.6	5.1	44.5	3.4	$p < 0.05$	34.9	2.3	50.4	6.0	$p < 0.05$
Strength endurance of the gluteal and spinal muscles, s	45.8	1.9	51.7	5.3	$p < 0.05$	45.5	1.5	59.4	3.7	$p < 0.05$
Flexibility of the spine, range of motion of the hip joints, and hamstring elasticity, cm	3.8	1.1	6.9	1.4	$p < 0.05$	4.4	1.2	11.1	2.6	$p < 0.05$
Static balance: Flamingo balance test, the number of falls in 60 seconds of balancing	4.9	1.7	4.1	1.1	$p > 0.05$	4.9	1.4	3.4	1.0	$p > 0.05$
Strength of the spinal extensors, N	207.6	3.3	219.5	3.8	$p > 0.05$	203.5	3.4	230.4	3.6	$p < 0.05$
Strength of the spinal flexors, N	158.2	2.1	169.2	3.6	$p > 0.05$	150.9	2.4	178.4	4.0	$p < 0.05$

Strength endurance of the spinal erectors increased by an average of 21.58%, the strength endurance of the abdominal muscles (maintenance of the trunk in the inclined position at an angle of 45° relative to the floor, hands along the trunk, reach forward with hands) increased by 4.19 %, flexibility increased by 81.58% (from 3.8 cm to 6.9 cm), and strength endurance of the gluteal and spinal muscles increased by 12.88% ($p < 0.05$). In women of the EG, statistically significant changes ($p < 0.05$) were found in the following variables: general endurance increased by an average of 18.84%, strength endurance of the spinal erectors increased by an average of 44.41%, strength endurance of the abdominal muscles increased by an average of 12.40%, strength endurance of the gluteal and spinal muscles increased by an average of 30.55%, flexibility of the spine, range of motion of the hip joints and hamstring elasticity increased by an average of 2.54 times.

The data obtained demonstrate an increase in the strength of the spinal extensor muscles in women of the EG by an average of 13.22% and the strength of the spinal flexors increased by 18.22% ($p < 0.05$), while there were no significant changes in these parameters in women of the CG ($p > 0.05$).

The increase in the strength of the muscle groups in the participants of the proposed corrective program indicates the improvement in muscle balance and strengthening of the corresponding muscle groups.

The results of the study indicate statistically significant improvements in all of the studied parameters of physical fitness in women of the EG compared to women of the CG ($p < 0.05$).

Discussion

The results of the authors (Cruz-Ferreira, 2013; Drzał-Grabiec, 2013-2014; Sakmenova, 2016; Spirin, 2012) who have been studied the characteristics of the body posture in human ontogenesis were further

developed. The obtained data confirm, supplement and expand the scientific knowledge in this field. The results of our study on the characteristics of the body posture in women in early adulthood are fully consistent with the data of Drzał-Grabiec (2014) and Sakmenova (2016), which indicated the high prevalence of functional disorders of the musculoskeletal system in this population group. The obtained data confirm the findings of the researchers (Fomenko, 2015; Kashuba, 2016a), who established that the changes in the biogeometric profile of the posture impair the highly differentiated total structure of the biokinematic chain of the spine. Our studies confirm the data of scientific researches (Spirin, 2012; Fomenko, 2015), which demonstrate that posture abnormalities can affect the goniometric characteristics of the body.

The analysis of the results of the study allowed us to expand the data on the physical preparedness of women with different types of posture in early adulthood (Bibak, 2013; Drzał-Grabiec, 2013). The materials of our study develop, to a certain extent, the data of the authors (Cruz-Ferreira, 2013; Sakmenova, 2016) on the focus of special exercises for correction of posture abnormalities (symmetric, stretching, general, and breathing). We also extend the data of the studies (Moroz, 2011; Ivanchykova, 2018; Sharajeva, 2018; Voronkov, 2018), which have been showed the positive effect of fitness programs using health-enhancing exercises on the level of physical condition of women in early adulthood. Summarizing the views of the experts in the field (Bibik, 2010; Kashuba, 2012-2018; Andrieieva, 2017b; Yarmak, 2017a), it is possible to conclude that systematic physical exercises can contribute to achievement of a set of health-improving objectives, among which are strengthening of the skeletal muscles and improvement in the respiratory, cardiovascular, and other systems of the body. The new data are the justification of the program for correction of postural abnormalities in young women by means of health-enhancing fitness classes, which consists of three stages, such as preparatory, main, and maintaining, as well as includes five models of the classes, five blocks, which have different targeted focuses (warm-up, aerobic, corrective/preventive, stretching, and warm-down), and six sets of corrective physical exercises, which ensure the effectiveness of the organization of health-enhancing fitness classes for women in early adulthood. Thus, the data obtained in the study provide clear ideas about the specifics of the correction of postural abnormalities in women in early adulthood through the health-enhancing physical exercise.

Conclusion

Most of the young women had postural disorders, and only 25% of the subjects had normal posture. The scoliotic posture was found in 35,11% of women, the round back posture was in 21.28%, the round hollow back posture was in 11,70%, and the flat back posture was in 6,38% of women.

The data of the ascertaining experiment allowed to determine the specific goniometric characteristics of the women body in early adulthood, which are characteristic for different types of body posture. For example, the biacromial angle (the angle of inclination of a line passing through both acromions) was an average of 2.3° ($S = 0.43^\circ$) in women, who did not have posture abnormalities, while it was an average of 4.2° ($S = 1.17^\circ$) in subjects with scoliotic posture, 3.7° ($S = 1.32^\circ$) in the ones with round hollow back, and 3.6° ($S = 1.19^\circ$) in women with round back ($p < 0.05$). In women with abnormal posture with a reduced physiological curvature of the spine (flat back), the biacromial angle was an average of 3.2° ($S = 1.12^\circ$) ($p > 0.05$).

Using the method of electric tensodynamometry, the strength topography of the individual muscle groups was determined and imbalance in the development of the strength of these muscles was identified in women with different posture types. The results of functional performance tests assessing the static strength endurance of the spinal erectors, static strength endurance of the gluteal and spinal muscles, strength endurance of the abdominal muscles, flexibility of the spine, the range of motion of the hip joints and hamstring elasticity, as well as static body balance, demonstrated statistically significant differences ($p < 0.05$) between the groups of women with various posture abnormalities and women with normal posture in early adulthood.

Implementation of the developed authorial corrective technology in the process of health enhancing fitness classes for women in early adulthood with posture misalignments in the frontal plane resulted in the significant improvement in the goniometric characteristics of the spatial organization of the body. In women of the EG, the biacromial angle decreased on average from 4.4° ($S = 1.2^\circ$) to 2.6° ($S = 0.5^\circ$), and the scapular balance angle decreased on average from 5.0° ($S = 1.1^\circ$) to 2.9° ($S = 0.5^\circ$) ($p < 0.05$). In contrast, no positive changes in these variables were found in the women of the CG: the biacromial angle decreased on average from 4.6° ($S = 1.1^\circ$) to 3.9° ($S = 1.1^\circ$), and the scapular balance angle decreased on average from 5.3° ($S = 1.1^\circ$) to 4.6° ($S = 1.0^\circ$) ($p > 0.05$).

After conducting the pedagogical experiment, in women of the EG, statistically significant positive changes ($p < 0.05$) were observed in the measures of general endurance, strength endurance of the spinal erectors, strength endurance of the abdominal muscles, strength endurance of the gluteal and spinal muscles, strength of the spinal extensors and flexors, flexibility of the spine, range of motion of the hip joints, and hamstrings elasticity. In comparison, in women of the CG, statistically significant changes ($p < 0.05$) were found in the measures of strength endurance of the spinal erectors, strength endurance of the abdominal muscles, flexibility of the spine, range of motion of the hip joints, and hamstrings elasticity, as well as general endurance and strength

endurance of the gluteal and spinal muscles ($p < 0.05$). The pedagogical experiment confirmed the effectiveness of the developed authorial program.

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Conflict of interests.

The authors declare that there is no conflict of interests.

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