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Original Article

Personalization of health-promoting fitness programs for young women based on genetic factors

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Abstract.
The study was focused on the substantiation of a personalized approach to designing health-promoting exercise programs for young women based on the genetic factors. To achieve the defined objectives the following methods were used: theoretical analysis and generalization of the data of scientific and methodological literature; surveys and questionnaires; anthropometric methods and methods of assessing cardiorespiratory function; pedagogical methods (pedagogical observation, testing, and experiment); molecular genetic methods (collection of genomic DNA by buccal swabs, DNA typing by polymerase chain reaction); methods of mathematical statistics.
On the basis of the data of biological and pedagogical studies of young women, the relevance of considering genetic factors in determining the type and content of fitness classes was substantiated. The effectiveness of different training modes to improve health status was studied in young women carrying different allelic variants of the *ACE*, *eNOS*, and *PPARG* genes. Genetic markers associated with high physical performance have been identified. A quantitative assessment of differences in physical status parameters between the groups of female carriers of different variants of the genes was carried out for predicting the effectiveness of health-promoting fitness classes. The paper provides scientific support for the criteria applied to personalize health-promoting fitness programs by varying the ratio of concurrent aerobic and resistance training depending on the genetic factors. An algorithm was suggested to personalize fitness programs for young women by considering the genetic factors.
Key words: physical condition, young women, health-promoting fitness, gene polymorphisms, genetic factors.

Introduction.

Preserving and promoting the public health and preventing diseases by engaging in systematic physical exercise is one of the government policy areas of most European countries (Earle, Baechle, 2008; et al.). One of the main tasks of physical education is developing a strong motivation to and a need for preserving and promotiong the health, physical development and physical fitness, and utilizing physical education means in the organization of healthy lifestyle (Hakman, 2019;Kashuba, et al, 2019). This issue is effectively addressed by engaging people in health-promoting fitness classes (Davydov, Shamardin, Krasnova, 2005). Various fitness classes in health club settings play a crucial role in preserving the health of the people.

The health-promoting effects of modern forms of physical activity are mediated by the activation of the most important functional systems of the body (Howley, Franks, 2003; Ivaschenko, 2008; Ivchatova, 2011, et al.; Kashubaet al. 2019).

The analysis of scientific research, the results of which have been implemented into the practice of fitness clubs over the past decades (Martyniuk, 2011; etc.), shows that the effectiveness of fitness programs does not always reach the maximum result in most cases. Each of the methods of using modern forms of physical activity has both advantages and disadvantages. Therefore, at present, the development of the health fitness sector cannot be done without the scientifically sound implementation of modern innovative technologies into the fitness industry. One of the most promising research areas in this field is the study of molecular genetic markers that determine the functions of the body associated with physical performance (Akhmetov, 2009). These genetic markers include polymorphisms in genes related to anthropometric measurements and body composition, cardiovascular and respiratory function, as well as genes encoding enzymes, coenzymes, and proteins involved in carbohydrate, fat, and mineral metabolism (Rankinen, et al, 2006). The use of modern molecular genetic technologies in health fitness make it posssible to take into account the individual characteristics of the body's adaptation to physical exercise, genetic predisposition to a disease, and features of metabolism that, in turn, will contribute to the health-enhancing and plastic effects of physical exercise. In view of the above, the search for effective criteria for designing a personalized fitness program for young women considering the genetic predisposition is a relevant objective. The results of such studies will allow us to develop approaches and practical recommendations for determining exercise loads in traditional and new types of fitness classes.

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Materials and Methods.

In the study, the following methods were used: analysis and generalization of special scientific and methodological literature; surveys and questionnaires (to study the motivation of young women to physical activity); anthropometric methods (measurement of body mass index (BMI), Pignet index, estimation of body composition by bioelectric impedance analysis); functional methods to assess cardiorespiratory function under various testing conditions; estimation of the level of physical condition by the Pirogova's method of predicting physical condition; molecular genetic methods (collection of genomic DNA by buccal swabs, DNA typing by polymerase chain reaction); pedagogical methods: pedagogical observation was used to analyze the effects of fitness classes on the body of young women taking into account genetic factors; pedagogical testing of motor skills was used to evaluate physical fitness of women; pedagogical experiment was used to evaluate the effects of different types of exercise training (aerobic, resistance, and combined workouts) on physical condition of young women; methods of mathematical statistics (Byshevets, et al, 2019).

The studies were carried out at the Leonardo wellness club. Genotyping was performed at the Laboratory of general and molecular pathophysiology of the Bogomolets Institute of Physiology of the National Academy of Sciences of Ukraine. Body composition was measured at the Department of theory and methodology of sports training and reserve capabilities of athletes of the Scientific Research Institute of the National University of Physical Education and Sport of Ukraine.

The study involved 44 young women aged from 23 to 35 years who participated in fitness classes at the Leonardo wellness club. Among them, 80% have participated in fitness classes for a period up to one year, 6% – for a period from one to two years, and 4% – for a period of more then two years.

At the beginning of the pedagogical experiment, we formed two groups of women, the experimental group 1 (EG1) (resistance training, n = 24) and the experimental group 2 (EG2) (aerobic training, n = 20). When analyzing the training results, each group of the women was further divided into two subgroups according to the *PPARG* genotype. As a result, four subgroups participated in the study: REG1 – women with Pro/Pro allelic variant of the *PPARG* gene (resistance training); REG2 – women with Pro/Ala or Ala/Ala allelic variant of the *PPARG* gene (resistance training); AEG1 women with Pro/Pro variant of the *PPARG* gene (aerobic training); and AEG2 – women with Pro/Ala or Ala/Ala variant of the *PPARG* gene (aerobic training). The health-promoting fitness programs of the main period were lasted for 4 months (two mesocycles).

Results.

We investigated the association of the *ACE*, *eNOS*, and *PPARG* genes polymorphisms with the level of physical condition of young women participating in fitness classes (Table 1).

Table 1. The level of physical condition of young women with different genotypes participating in fitness classes

Gene	Level of physical condition	Percentage of women, %		
		Genotype I/I (n=15)	Genotype I/D (n=23)	Genotype D/D (n=6)
ACE (n=44)	low	–	8.7	–
	lower than average	–	17.4	50.0
	average	40.0	34.8	50.0
	higher than average	53.3	34.8	–
	high	6.7	4.3	–
		Genotype T/T (n=23)	Genotype T/C (n=19)	Genotype C/C (n=2)
eNOS(n=44)	low	–	5.3	–
	lower than average	17.4	15.8	–
	average	43.5	36.8	50.0
	higher than average	34.8	36.8	50.0
	high	4.3	5.3	–
		Genotype Pro/Pro (n=30)	Genotype Pro/Ala (n=13)	Genotype Ala/Ala (n=1)
PPARG (n=44)	low	–	–	–
	lower than average	13.3	15.4	–
	average	36.7	61.5	100.0
	higher than average	46.7	15.4	–
	high	3.3	7.7	–

An increase in the number of I alleles of the *ACE* gene is associated with higher index of physical condition, i.e. the deletion (D) in the gene is associated with poor physical condition of the women. Analysis of the *eNOS* gene indicated that there are no significant differences in the distribution of women with different levels of physical status between the subgroups identified by the T/C polymorphism. Genotyping of *PPARG* gene polymorphisms in women revealed only one woman with the Ala/Ala genotype in the sample, so women with the Pro/Ala and Ala/Ala genotypes were grouped into one subgroup of Ala-allele carriers. The average group level of physical condition calculated by the method of predicting physical condition was 0.65±0.11 in women with Pro/Pro genotype and 0.60±0.13 in Ala-allele carriers. There were no differences between the two subgroups.

Among the polymorphisms studied, only variants of the *PPARG* gene were significantly associated with body constitution. To evaluate the body constitution, Pignet index was used. The *PPARG* gene polymorphism was shown to significantly affect the values of Pignet index (p=0.031). In the Pro/Pro genotype group, Pignet index was 2.1 times higher (p <0.01) than in the Ala-allele carriers group (22.5% and 10.6%, respectively). The presence of the Ala allele contributes to increased body weight and the hip and the abdomen measurements of women. In the subgroup of Ala-allele carriers, all women (100%) had a body weight that exceeded the standard by more than 5.0%. The analysis of the body build gave the following distribution of women with the Pro/Pro genotype: 80% of normostenics, 10% of hyperstenics, and 10% of hypostenics. In the subgroup of Ala-allele carriers, the proportion of normostenics decreased by 5.7%, there were no hypostenics, and the proportion of hyperstenics was increased by 25.7%, that also supports the hypothesis about the association of *PPARG* gene variants with the characteristics of anabolic processes in the body. These results suggest that PPARG genotyping can be used to personalize health-promoting fitness programs. The data of genetic status and morphofunctional parameters assessment were used to develop aerobic and resistance training fitness programs for young women with Pro/Pro, Pro/Ala, and Ala/Ala genotypes of REG1, REG2, AEG2, and AEG2 subgroups.

The resistance training fitness program of moderate intensity for women included a set of resistance exercises to develop strength endurance and improve posture, and aerobic exercise to develop general endurance and lose weight (Table 2). The resistance exercise were aimed at strengthening the skeletal muscles and developing strength, increasing bone density, that contributes to the prevention of osteoporosis and reduction in the risk of fractures as well as to the increase of internal body temperature and intensity of metabolic processes. The objectives of aerobic training were to improve the functional abilities, first of all, of the cardiorespiratory system and musculoskeletal system, and to increase energy expenditures during workouts mainly due to the fat oxidation. The aerobic training fitness program (aerobics and jazz gymnastics) included mainly dynamic exercises, while static and stretching exercises were used to a lesser extent (Table 2).

Table 2. Characteristics of the aerobic and resistance training fitness programs for young women with Pro/Pro, Pro/Ala, and Ala/Ala genotypes of REG1, REG2, AEG2, and AEG2 subgroups

Program component	Resistance training fitness program (for REG1 and REG2 subgroups)	Aerobic training fitness program (for AEG1 and AEG2 subgroups)
Objectives	• increasing the level of physical condition and physical activity; • improvement of body composition; • reducing the risk of some diseases; • increasing physical fitness and physical performance.	• increasing the level of physical condition and physical activity; • change in body composition; • improvement of the functional state of the cardiorespiratory system; • increasing physical fitness and physical performance.
Frequency of workouts	3-4 times a week	
Duration of workouts	45-60 minutes	
Recommended exercises	resistance exercises with a load of 20-50% of max load in the interval mode and endurance resistance exercise in the continuous and variable modes.	aerobic training combined with resistance exercise with a load of 40-60% of max load in continuous and interval modes.
Percentage of general exercises specific exercises	 25 – 40% 60 – 75%	 60 – 75 % 25 – 40%
Aerobic heart rate zones: – training – recovery	 140-160 bps 120-130 bps	 140-160 bps 110-130 bps
Exercise intensity: – aerobic – resistance	50-70% of VO_2 max 14-16 RM or 11-12 points on the Borg scale	40-50% of VO_2 max 10-12 RM or 10-12 points on the Borg scale
Methodological recommendations	For the transition to the main period of physical training, it is necessary to increase the resistance during the first month and then to increase the number of repetitions. An increase in the exercise load may be followed by another increase in the resistance and, then, in the number of repetitions.	The program involved a holistic approach, prevalence of aerobic exercises (75% of the total workout time), and no high-intensity exercise series.
Additional means	recreational activities, recovery tools (sauna, massage).	

The criteria for measuring the effectiveness of fitness classes included: decrease in resting heart rate and resting respiration rate; blood pressure normalization; improvement of functional tests and exercise tests results; improvement of indices of body proportionality.

The analysis of the results of the study presented in Table 3 showed that the changes in the indicators of physical condition of young women depend on genetic factors. The fitness classes resulted in a decrease in body weight of 4.7% in the REG1 group and of 2.28% in the REG2 (p <0.05). Thus, the resistance training leads to less significant changes in body weight of women of the second experimental group. Similar differences between the groups were also observed in the changes of the BMI index. At the beginning of the study, BMI in the first experimental group was 17.4% lower than in the REG2. After the formative experiment, BMI decreased by 4.8% in the REG1 and by 2.29% in the REG2.

Table 3. Parameters of physical condition of young women with different genotypes participating in resistance training ($\bar{x}$±S) (n=24)

Parameters	...			
	REG1		REG2	
	ascertaining experiment	formative experiment	ascertaining experiment	formative experiment
Body weight, kg	60.1±5.76	57.2±5.54	74.6±4.32**	72.9±4.26*
BMI	21.2±1.77	20.2±1.69	24.9±3.70*	24.3±3.65
Chest circumference, cm	90.4±2.65	89.4±2.49	94.6±10.33	94.0±11.27
Waist circumference, cm	69.1±3.31	66.9±3.26	75.3±10.21	73.1±10.11
High hip circumference, cm	95.8±3.11	93.6±3.54	101.0±9.36	99.2±9.28
Hip circumference, cm	55.7±2.78	53.8±2.59	59.0±6.21	57.7±6.22
Abdomen circumference, cm	74.5±6.11	70.8±5.34 **	80.8±11.25*	76.7±11.29**
Fat mass, %	19.2±1.32	17.4±1.49**	24.0±6.41*	21.8±5.74
Non-fat mass, %	80.8±1.38	82.6±11.48	76.0±6.43	78.2±17.81**
Resting heart rate, bpm	78.8±11.19	70.8±10.39	81.1±7.26	77.9±7.33
Systolic blood pressure, mm Hg	119.3±14.27	113.9±13.25	122.0±14.26	117.5±13.81
Diastolic blood pressure, mm Hg	73.9±6.39	70.3±6.55	75.2±7.29	71.3±7.78
Robinson index, arb. units	55.5±11.27	49.9±9.54	61.3±10.39	55.9±10.22
Ruffier index, arb. units	2.2±0.07	1.8±0.06	4.3 ±0.18	3.5±0.12
Physical condition index	0.63±0.11	0.70±0.14**	0.57±0.13*	0.63±0.10**

Note: * – the difference between groups is statistically significant (p<0.05); ** – the difference between the experiments data is statistically significant (p<0.05)

All of the body circumference measures were decreased in both groups after resistance training, however significant changes were found only in hip and abdomen girth. In the REG1, pelvic circumference was decreased by 2.3% and abdomen circumference – by 5.0% (p<0.05), while in the REG2, these parameters were decreased by 1.7% and 5.0% (p<0.05), respectively. Therefore, in the women of the first experimental group, resistance exercise resulted in more noticeable changes in anthropometric parameters than in the women of the second group. Nevertheless, the changes in the body composition of young women with different genetic characteristics induced by resistance training had a different pattern. The amount of fat tissue decreased by 1.7% n the first experimental group and by 2.2% (p<0.05) in the second experimental group. In both groups, the percentage of fat-free tissue increased due to reducing body weight and increasing muscle mass. The increase was 3.9% (p <0.05) in the first group and 5.6% (p <0.05) in the second group. Thus, in the women of REG2, resistance training resulted in significant changes in the body composition combined with a slight decrease in body weight and circumference parameters. In the women of REG1, weight loss and decrease in circumference measures of the body was more substantial, while the body composition was slightly changed.

Heart rate decreased by 4.8%, diastolic and systolic blood pressure decreased by 4.2% and 4.9%, respectively. The Robinson Index, also known as double product, is an indicator of the myocardial workload. This index was estimated by the Apanasenko method and decreased significantly (by 9.6%) in all women.

The Ruffier Index, which reflects physical performance, decreased by 18.7%. Although the results of the Ruffier test at the beginning of the pedagogical experiment differed significantly between group 1 and group 2, they improved significantly in both groups after resistance training. The Ruffier Index decreased by 15% in the women of the first experimental group and by 20% in the women of the second experimental group.

After four months of training, the physical condition index increased significantly by 9.8% (p <0.05). The distribution of women by the level of physical condition also changed. We did not found individuals with low levels of physical condition at the end of the pedagogical experiment. The number of women with the high level of physical condition increased by 12.5%, while the amount of the women with the lower than average level decreased by 8.4%. The patterns of the changes in the parameters of physical condition differed between the women of subgroup AEG1 (Pro/Pro genotype) and subgroup AEG2 (Pro/Ala and Ala/Ala genotypes) who participated in aerobic training (Table 4).Aerobic training resulted in significant changes in body weight of young women in both groups. The mean group body weight decreased by 4.3% ($p<0.01$) in the AEG1 group and by 6% ($p<0.05$) in the AEG2 group. BMI decreased by 4.6% ($p<0.01$) in the AEG1 group and by 6,6% ($p<0.05$) in the AEG2 group.

Resting heart rate decreased in both groups: by 6.1% in AEG1 and by 6.9%) ($p<0.01$) in AEG2. Systolic blood pressure did not change significantly in AEG1 and decreased by 1.9% in AEG2. Diastolic pressure decreased significantly only in AEG1 (by 9.8%, $p<0.01$). The Robinson Index decreased both in AEG1 (by 6.6%, $p<0.01$) and in AEG2 (by 8.8%, $p <0.05$). The Ruffier Index decreased by 34% ($p<0.01$) in AEG1 and by 29.1% ($p<0.01$) in AEG2.

After four months aerobic training, 6.7% of women in the AEG1 group have improved their physical condition to the high level.

Table 4. Parameters of physical condition of young women with different genotypes participating in aerobic training ($\bar{x}$±S) (n=20)

Parameters	AEG1		AEG2	
	ascertaining experiment	formative experiment	ascertaining experiment	formative experiment
Body weight, kg	57.8±7.12	55.2±7.03*	62.0±5.12	58.3±4.23*
BMI	19.8±1.49	19.0±1.67*	22.4±0.76	20.7±0.15*
Chest circumference, cm	85.9±5.11	86.9±5.31	82.0±2.62	83.2±2.67
Waist circumference, cm	69.7±5.22	67.3±5.12	66.9±5.11	62.4±5.17
High hip circumference, cm	92.3±4.28	90.9±4.34	86.9±4.51	84.6±4.51
Hip circumference, cm	50.9±2.67	48.3±4.55	46.9±4.29	40.5±5.18
Abdomen circumference, cm	72.3±5.29	69.5±5.43*	71.6±5.25	67.4±5.83*
Fat mass, %	24.3±4.11	23.4±4.26*	22.4±3.42	21.1±3.49*
Non-fat mass, %	75.7±4.34	76.6±4.37*	77.6±3.39	78.9±3.51*
Resting heart rate, bpm	70.4±6.25	66.1±5.21*	77.6±9.47	72.2±8.35*
Systolic blood pressure, mm Hg	115.8±11.28	116.7±5.21	110.2±11.06	108.2±10.42
Diastolic blood pressure, mm Hg	76.6±8.26	69.1±5.66*	69.6±11.81	69.8±6.13
Robinson index, arb. units	81.3±8.18	75.9±5.11*	85.9±16.21	78.4±14.27*
Ruffier index, arb. units	13.5±4.11	8.9±4.18*	17.9±4.15	12.7±4.48*
Physical condition index	0.68±0.05	0.75±0.06*	0.66±0.11	0.71±0.10

Note: * – the difference between groups is statistically significant ($p<0.05$); ** – the difference between the experiments data is statistically significant ($p<0.05$)

The number of women with the higher then average level of physical condition increased by 20.0%, while the number of the women with the average level decreased by 20.0%. In the AEG2 group, the number of women with the higher than average level of physical condition increased by 20.0%, while the percentage of women with the low level decreased to zero. The most significant changes in the level of physical condition after aerobic training occurred in the AEG1 group (women with the Pro/Pro genotype). Although both groups experienced changes in the cardiovascular system parameters that indicates an improvement in the functional state of this system, the largest increase occurred in the AEG1 group.

On the basis of identified characteristics of physical condition of young women and results of the analysis of advantages and disadvantages of existing methodologies and programs of conditioning training programs, we have provided rationale for the development of fitness programs with different ratios of aerobic and resistance exercise depending on genetic characteristics that allow to individualize fitness training for women taking into account their morphofunctional parameters.

Based on our research, we have developed an algorithm for personalizing the program of health-promoting fitness training taking into account genetic characteristics of young women, which included the following:

– assessment of the motivation to participate in fitness classes, the evel of physical condition, morphometric parameters (carried out by an instructor of the club, in accordance with job responsibilities);

– medical examination, identification of risk indicators and risk factors for morbidity (carried out by a sports physician of the club according to the club's instructions and regulations);

– assessment of genetic factors: collection of buccal swab samples (carried out by a sports physician using disposable test kit that consists of sterile swabs and tubes with a reagent for collection and preservation of DNA samples).

– development of practical recommendations for personalization of fitness program taking into account genetic factors and level of physical condition: determination of the duration of the main period and the mesocycle depending on the level of physical condition; selection of the structure of fitness workouts (number of blocks, their content, and duration vary depending on the allelic variants of *ACE*, *eNOS*, and *PPARG* genes; determination of exercise intensity and heart rate zones depending on allelic variants of *ACE* and *eNOS* genes; selection of the ratio of aerobic and resistance exercise depending on the allelic variants of *ACE* and *PPARG* genes;

– adjustment of the fitness program parameters at the end of each mesocycle taking into account the changes in morphometric measures and functional status of women.

To assess the effectiveness of the program the following criteria are used: changes in heart rate, blood pressure, body mass index, circumference indices, and body composition and approximation of the parameters to normative values.

Discussion.

Clients are often faced with the fact that training do not produce the desired effect, and the existing chronic health conditions make it impossible for them to choose the right type of physical activity. The effectiveness of fitness training can be significantly improved through the use of genetic information. The number of studies focused on examining the contribution of genetic factors to improving the health-promoting effects of fitness training has increased significantly in recent years. The understanding of the influence of genetic factors, which determine the body response to exercise training, provide an opportunity to design individualized fitness programs for clients. Genetic analysis will help to choose appropriate physical activities for people with health problems. Nevertheless, only a few studies have addressed the use of molecular genetic data in fitness training. The association was found between the polymorphisms of PPARA and PPARD genes regulating skeletal muscle metabolism and improvement in anthropometric and strength parameters that resulted from exercise training. The data on the PPARA and PPARD genes polymorphisms make it possible not only to predict the improvement of anthropometric and strength parameters of clients in resistance training programs taking into account the body type, but also to adjust the parameters of the training load (Ahmetov, 2009, Gineviciene,et al, 2014).

The results of molecular-genetic analysis of DNA samples of elite bodybuilders and powerlifters, as well as individuals engaged in body fitness and fitness training, indicate the significant influence of gene variants (alleles) on performance in these physical activities (Akhmetov, 2008). It has been found that the presence of certain gene alleles gives an advantage in the development of strength and muscle growth. The deletion variant of the ACE gene was shown to be associated with obesity (Makarov, 2007). Overweight women engaged in exercise training in fitness clubs have a high frequency of alleles associated with the risk of obesity.

The study of association between genes polymorphisms and physiological and anthropometric characteristics of women engaged in health-promoting physical activity programs demonstrated the highest values of body mass index and fat mass in PPARGC1A Ser/Ser and UCP3-55C/T genotype carriers. The study of the functional capacity of the cardiovascular system showed that the highest level of physical performance (PWC170) is observed in PPARA GG genotype carriers (Ahmetov, Dondukovskaya, Ryabinkova, 2008).

The results of the study indicate that PPARA G, PPARGC1A Gly, and UCP2 Val alleles are associated with endurance performance, while PPARA C, PPARGC1A Ser, and UCP2 Val alleles are related to risk of developing obesity. Furthermore, association of UCP3-55C/T polymorphism with dynamometric measurements was revealed in women engaged in health-promoting fitness training.

We have confirmed the findings of previous studies that health-promoting exercise training contributes to improving the physical condition, physical fitness, and morphofunctional parameters of young women (Ivchatova, 2005, Goglyuvataya, 2007;Drozdovskaya, et al, 2012), and that the training effect of fitness classes depends on genetic factors (Ahmetov, Dondukovskaya, Ryabinkova, 2008). The analysis of the genetic characteristics of young women engaged in health-promoting exercise training identified the association between the women's body mass index, physical condition index, and body type and ACE and PPARG genes allelic variants. These results are consistent with those of other studies (Ahmetov, 2009).This research extends our knowledge of the factors that affect the effectiveness of exercise training as a health promotion tool (Ivchatova, 2005; Martyniuk, 2010) and of the genes that are associated with physical performance (Gineviciene,et al, 2014).

Further, the study provides the data about the relationships between the level of physical condition, indicators of physical fitness and morphofunctional characteristics of women engaged in health-promoting fitness training and their genetic characteristics; about the the effectiveness of various types of exercise training in women with different genetic characteristics; and about the possibility of personalizing the program of health-promoting fitness classes taking into account gene polymorphisms. This study has also shown that different types of exercise training affect the physical condition of women with different genetic characteristics in the same manner, but the extent of the influence varies.

Conclusions.

Thus, identification of genetic markers makes it possible to use personalized approach to designing customized fitness programs that includes selection of the structure of training classes depending on the *ACE*, *eNOS*, and *PPARG* genes allelic variants; selection of the ratio of aerobic and resistance exercise, depending on

ACE and *PPARG* genes allelic variants; and selection of intensity of the training load and heart rate training zones depending on the *ACE* and *eNOS* genes allelic variants.

Conflict of Interest

All the authors declare to have no conflict of interest.

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