THE EFFECTS OF A PILATES-AEROBIC PROGRAM ON MAXIMUM EXERCISE CAPACITY OF ADULT WOMEN

EFECTOS DE PROGRAMA DE PILATES AERÓBICO SOBRE LA CAPACIDAD MÁXIMA DE EJERCICIO EN MULHERES ADULTAS

EN MULHERES ADULTAS

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ABSTRACT

Introduction: Physical exercise such as the Pilates method offers clinical benefits on the aging process. Likewise, physiologic parameters may be improved through aerobic exercise. Methods: In order to compare the differences of a Pilates-Aerobic intervention program on physiologic parameters such as the maximum heart rate (HRmax), relative maximal oxygen consumption (relative VO2max) and absolute (absolute VO2max), maximum heart rate during maximal oxygen consumption (VO2max-HRmax), maximum minute volume (VE) and forced vital capacity (FVC), a total of 64 adult women (active group = 48.1 ± 6.7 years; control group = 47.2 ± 7.4 years) participated in the study. The physiological parameters, the maximal speed and total duration of test were measured by maximum exercise capacity testing through Bruce protocol. The HRmax was calculated by a cardio-ergometric software. Pulmonary function tests, maximal speed and total time during the physical test were performed in a treadmill (Medisoft, model 870C). Likewise, the spirometry analyzed the impact on oxygen uptake parameters, including FVC and VE. Results: VO2max (relative and absolute), VE (all, P<0.001), VO2max-HRmax (P<0.05) and maximal speed of treadmill test (P<0.001) showed significant difference in the active group after a physical exercise intervention program. Conclusion: The present study indicates that the Pilates exercises through a continuous training program might significantly improve the cardiovascular system. Hence, mixing strength and aerobic exercises into a training program is considered the optimal mechanism for healthy aging.

Keywords: aging; exercise test; oxygen consumption; exercise.

RESUMO

Introdução: O exercício físico, como Pilates, proporciona benefícios clínicos no processo de envelhecimento. Do mesmo modo, os parâmetros fisiológicos podem ser melhorados pelo exercício aeróbio. Métodos: A fim de comparar as diferenças de um programa de intervenção com Pilates aeróbico em parâmetros fisiológicos, como frequência cardíaca máxima (FCmax), consumo máximo de oxigênio relativo (VO2max relativo) e absoluto (VO2max absoluto), frequência cardíaca máxima durante o consumo máximo de oxigênio (VO2max-FCmax), volume minuto (VM) máximo e capacidade vital forçada (CVF), um total de 64 mulheres adultas (grupo ativo = 48,1 ± 6,7 anos, grupo controle = 47,2 ± 7,4 anos) participaram do estudo. Os parâmetros fisiológicos, velocidade máxima e a duração total do teste foram medidos pelo teste de capacidade máxima de exercício pelo protocolo de Bruce. A FCmax foi calculada por um software cardíaco-ergométrico. Os testes de função pulmonar, velocidade máxima e tempo total durante o teste físico foram realizados em esteira rolante (Medisoft, modelo 870C). Da mesma forma, a espirometria analisou o impacto sobre os parâmetros de captação de oxigênio, incluindo FVC e VE. Resultados: VO2max (relativo e absoluto), VM (todos, P<0.001), VO2max-FCmax (P<0.05) e velocidade máxima do teste ergométrico (P<0.001) mostraram diferença significativa no grupo ativo após um programa de intervenção física. Conclusão: Este estudo indica que os exercícios de Pilates por meio de um programa de treinamento contínuo pode melhorar significativamente o sistema cardiovascular. Portanto, a mistura de exercícios de força e aeróbicos em um programa de treinamento é considerada o mecanismo ideal para o envelhecimento saudável.

Descritores: envelhecimento; teste de esforço; consumo de oxigênio; exercício.

RESUMEN

Introducción: El ejercicio físico de Pilates ofrece beneficios clínicos en el proceso de envejecimiento. Del mismo modo, los parámetros fisiológicos se pueden mejorar mediante el ejercicio aeróbico. Métodos: Con el fin de comparar las diferencias de un programa de intervención con Pilates aeróbico en los parámetros fisiológicos, como la frecuencia cardíaca máxima (FCmáx), consumo máximo de oxígeno relativo (VO2máx relativo) y absoluto (VO2máx absoluto), la frecuencia cardíaca máxima durante el consumo máximo de oxígeno (VO2máx-FCmáx), el volumen minuto (VM) máximo (VE) y la capacidad vital forzada (CVF), un total de 64 mujeres adultas (grupo activo = 48,1 ± 6,7 años; grupo control = 47,2 ± 7,4 años) participaron en el estudio. Los parámetros fisiológicos, la velocidad máxima y la duración total de la prueba se midieron por la máxima capacidad de ejercicio a través del protocolo de Bruce. La FCmáx se calculó mediante un software cardio-ergométrico. Las pruebas de función pulmonar, la velocidad máxima y el...
INTRODUCTION

The main characteristic of ageing is a gradual and inevitable deterioration of physical capacities and degenerative diseases. The physical fitness evolution during the ageing process decreases and it is necessary to guarantee a better understanding of elderly people and reduce their consequences. Moreover, it is common knowledge that ageing causes drastic reduction in physical fitness.

In the mid-nineties, there was a certain evolution in the way of thinking among the people engaged in recreational physical exercising. From that moment on there was the expansion of other group-guided programs, such as Pilates, yoga, Tai-Chi and other “body & mind” programs on the one hand, and, spinning, body pump, step aerobics, aqua aerobics and other “cardio” systems of exercising which put into focus the positive influence of exercising on psycho-physical health and general sense of well-being due to exercising. The Pilates method mixes a philosophy of health and well-being by means of brain cells activation, in turn, stimulating a positive impact on the mind and the body. This method was ranked seventh place by the ACSM as an emerging physical activity in 2008 and 2009, and in the US alone, the number of users reached 10.5 million in 2004. The Pilates method coincides with the modern principles of fitness, personal training, and mental happiness through exercises that maintain a neutral spine position and the use of the floor and equipment to develop the physical fitness in general. Therefore, Pilates programs can be physical activities with clinical benefits through several studies on the aging process.

Physical fitness is an integrated measurement of cardiorespiratory and endocrine-metabolic functions. The main function of the cardio-vascular and respiratory system is to supply the body with oxygen and nutrients, to release the body from carbon dioxide and metabolic by-products, to maintain the body temperature and acid-base balance and to transport hormones from endocrine glands to the place of their activity. These two systems respond to the increased activity of the skeletal muscles in a relatively predictable. The oxygen consumption efficiency has higher prognostic level than other cardio physiological parameters as the maximum minute ventilation in regard to carbon dioxide production.

The reduction of maximal oxygen uptake increases between f 0.5%–1.0% per year and it has an influence on the physical fitness on adult and elderly people. The oxygen uptake reserve level establishes a range between 50%-85% for aerobic exercises in elderly people, including moderate and vigorous exercises. Later researches, however, showed that when the level of declining of aerobic capability is expressed as a percentage of declining since the early adulthood, then this difference in favour of non-sedentary individuals is lost. Moreover, men and women who do some kind of endurance training, show greater absolute level of decline of aerobic ability (ml.Kg (-1), min (-1) with age than sedentary adults.

There are a lot of studies about heart rate capacity and cardiovascular system comparing the differences before and after physical exercise training. However, there are not abundant results of studies about physiologic parameters in adult women, specifically FVC, and before and after a mix of Pilates method and aerobic exercise. Therefore, the aim of the present study was to compare the differences in maximum exercise capacity and physiological parameters of a sample of adult females during six-months Pilates-Aerobic Interventional Program.

Measures and procedures

The participants were informed of the purpose of the present study. Written informed consent was obtained from all participants after receiving detailed information about the aims and study procedures of the current project.

Data was collected twice. The present study was initiated in May 2011 with a pre-test and concluded in November 2011, performing a post-test (six months). The interventional program had an 80% attendance rate during this period. The interventional program consisted of Pilates method and music-based aerobic (Aerobic and steps), basic to intermediate level. The sessions included in this interventional program took place twice per week, and lasted 55-60 minutes per day-session, with an effective physical activity time of 45 minutes, in line with the requirements laid by the ACSM. The physical fitness of participants and the performance of physical exercises were controlled by specialists. This study was approved by Ethical Committee of University of Novi Sad (114-451-2337/2011) and funded by the Provincial Secretariat for Science and Technological Development: “Impact of Physical Activity on the Risk Factors of the Working Population”.

A cross-sectional study was used to assess the oxygen uptake of female adult participants during a treadmill test. Body weight was measured to ± 0.1 kg on an electronic scale (SECA, Hamburg, Germany) with participants wearing light indoor clothing and no shoes. The physiological parameters were measured by maximum exercise capacity testing during the increase of speed and the degree of the ramp level each three minutes through Bruce protocol. Previous to maximum exercise capacity test, all participants answered a standard questionnaire according their medical history, health-related habits and smoking status. Both the questionnaire and the treadmill test were supervised by physicians from University of Novi Sad. The test was interrupted when the female participants reported maximal fatigue. The maximal exertion was determined as achieving ≥85% age-reported maximal heart rate (HRmax). Moreover, the Borg scale was used to quantify the sensation of shortness of breath during effort and at rest. The HRmax was calculated by cardio-ergometric program software (Cardiovox). Lung function testing and treadmill variables (maximal speed and total time during the test) were performed by treadmill testing (Medisof), model 870c and spirometry to analyze the VO2max, including forced vital capacity (FVC) and maximum minute ventilation (VE).
Statistical analysis

Normality of distribution was tested by means of the kolmogorov-Smirnov test. Clinical statistical methods were used for the calculations of the means and standard deviation (SD), minimal and maximum values of body composition parameters (age and body weight), physiological variables (HRmax, VO2max, VO2max-Hmax, VE and FVC) and Bruce protocol variables (maximal speed and total time during the test). In order to establish the differences in physiological variables and the Bruce protocol variables in the pre-post test, paired samples T-test was used for two different groups of participants. Data were analyzed using the SPSS statistical program (SPSS for Windows 19.0, Inc., Chicago, Illinois, USA). For all analyses, significance was accepted at P<0.05.

RESULTS

Table 1 shows descriptive parameters of body composition parameters such as age (active group= 48.1±6.7 years; control group= 47.2±7.4 years) and body weight (active group= 65.7± 6.2; control group=66.3±11.3), maximal heart rate (active group= 173.1±12.2; control group=168.9±12.3), minimum and maximum physiological variables of active group (HRmax= 143-189 bpm; VO2max relative= 20.6-37.6 ml/kg/min; VO2max absolute= 1.2-2.4 l/m; VO2max-Hmax= 134-189; VE= 38.2-86.1 l/min and FVC= 2.2-5.2 l) and control group (HRmax= 145-185 bpm; VO2max relative= 19.8-35.9 ml/kg/min; VO2max absolute= 1.2-2.4 l/m; VO2max-Hmax= 144-183; VE= 36.2-80.3 l/min and FVC= 2.2-5.2 l).

Finally, Bruce protocol variables were also descriptive in active group (maximal speed= 4- 6.8 km/h; total time during the test= 3.31-10.01 minutes) and control group (maximal speed= 4- 6.7 km/h; total time during the test= 4.28-9.04 minutes). Hence, the differences between minimal and maximum physiological parameters values of active and control group are scarce except VO2max-HRmax and VE (l/min). Regarding to treadmill test, the maximum speed between two groups studied is very similar whereas the total time during the exercise capacity test of active group presents less minimal time and higher maximum time of testing.

Table 2 shows descriptive physiological parameters and treadmill test values: mean, standard deviation (SD), pre-test/post-test and p-value. According to physiological parameters, there was differences in VO2max (relative), VO2max absolute), VE (all, P<0.001), and VO2max-HRmax (both, P<0.05) of the active group after a physical exercise interventional program. The variable of treadmill test showed difference in maximum speed (P<0.001). However, control group showed no significant differences during the period of 24 weeks-physical exercise interventional program.

DISCUSSION

The present study shows the improvement of an interventional program consisted of Pilates method and music-based aerobic (Aerobic and steps) in the maximum exercise capacity and physiological parameters of female participants.

All physiological parameters studied (VO2 max (relative), VO2max absolute), VE and VO2max-HRmax, except the FVC, experienced significant differences after a Pilates-Aerobic interventional program in the adult women studied. Nevertheless, the differences in physiological parameters and maximum exercise capacity of control group were not significant. The maximal oxygen uptake in the interventional group after the Pilates-Aerobic exercise intervention experienced an increase of relative oxygen consumption of two and half percent whereas the VO2max (absolute) increased by a minimal increase. Similarly, Pantelić et al.16, in a sample of 59 adult women, found statistically significant difference in physiological variables for evaluation of maximal capacity exercise between the initial and final measuring in the participant group of aerobic exercise program, while in the control group there was no significant difference. The results of the final measuring from the present interventional study have also shown that the created model of Pilates-Aerobic exercise shows positive effects on the physiological parameters in the participants of the active group. According to the conclusions of Deci and Ryan18,19, participants of imposed exercise programs by different high intensity interventions, could report important physiological adaptations.

Moreover, exercise of moderate intensity such as the interventional program of the present study, experiences different types of affective response to physiological parameters of participants18, as for example the FVC. The main cause of those different responses may be explained because of the relation of physiologic responses with the intensity of the exercise20. Likewise, the knowledge about physiological response to exercise in older adults is still scarce21. However, the VO2max-HRmax of participants in the interventional group experienced a minimal significant increase while the participants of the control group decreased. In the line of Smith, et al.21 study, this physiologic parameter might increase because of the higher effort of the participants of treadmill test but others studies have shown differences in VO2max and VO2max-HRmax with similar population in a fitness and aerobic exercise intervention program19.
The ACSM1 and other authors16,22,23 recommend following international exercise guidelines and experts where is described that the characteristics of an exercise program should contain continual exercise of 40-45 minutes with an intensity frequency between 50%-80%, whether the main objective of the exercise program is a improvement of VO2max, and VO2max-HRmax. According to the last assertion, an improvement of VO2max and maximal exercise capacity occurred after a fitness-aerobic (bench-step) exercise program with adult women24. If physical exercise program with adult and elderly people do not follow international guidelines, it is possible that the benefits would not be the expected. Similarly, the normal lung volume and VO2max decrease during the practice of exhaustive exercise25. Then, the physical exercise has a positive effect on improving maximal exercise capacity which has been shown in the results of the present study, considering that aerobic ability usually reaches its peak in the period between the age of 15 and 201,26. According to the pulmonary ventilation, the participants of the interventional group on final measuring achieved better values of variable VE compared to the control group whose values were similar and without significance differences. The rise in VE could be related to the increase of VO2max-HRmax because of high intensity of a maximal cardio-pulmonary exercise which is related with VO2max relative according to American Thoracic Society (ATS) and American College of Chest Physicians (ACCP)27. The Oliver et al.27 study where the increase of VE was related to maximal capacity exercise, showed similar physiologic parameters with participants of similar age but more weight. The results of the present study prove that respiratory system represents a limiting factor during the physical activity, especially in elderly people. Pulmonary ventilation represents the parameter of economical capacity; more precisely represents the product of frequency of breathing and depth of inhaling during various loads. The on-sight parameter without significant difference after the intervention neither the interventional group nor the control group is the FVC. However, the FVC improved in others studies as in a group of female participants ranged 40 years and more who participated in an interventional aerobic program28.

Finally, the total duration of treadmill exercise in active group increased after the interventional exercise program when the total duration of control group decreased. Several studies have proved that the combination of strength and aerobic exercise may be more effective on the cardio-vascular system and skeletal muscle mass in adult and elderly people22,23. Therefore, the participants of the active group could have improved the strength and physiological parameters after a Pilates-Aerobic interventional program and walking faster than participants of control group who was measured without to practice any physical activity guided.

CONCLUSION

In conclusion, the study indicates that the recreational exercise and continuous training program might significantly improve several physiologic parameters of adult women such as cardio-vascular system (relative and absolute VO2max, VO2max-HRmax and VE), which is important for women with similar age than the present participants. The loss of maximal capacity exercise can lead to the poorer quality of life. Larger differences in the VO2max values in groups that regularly have recreational trainings might be connected with their higher values in youth (base effect) or with a larger reduction of exercises in the elderly age. Hence, a mix of strength and aerobic exercise training program is considered as an optimal mechanism of a healthy aging.

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