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Effects of physical activity on the cardiovascular system: a systematic review

Armin Zećirović[1], Goran Vasić[2], Rosario D'Onofrio[3,4]

[1]*Faculty of Physical Education and Sports, University of East Sarajevo*

[2]*Faculty of Sport and Physical Education, Novi Sad*

[3]*Sapienza University of Rome – Italy*

[4]*Member of the Multidisciplinary Medical - Scientific Commission, - L.A.M.I.CA - Italy*

Abstract.

Research data for the purposes of this review were collected through electronic search engines PubMed, Scholar Google. After reviewing the entire texts according to the inclusion criteria, 15 papers remained, which are included in the detailed analysis and tabelar presentation .Physical activities of aerobic character give real results if performed 3-5 times a week. The duration of the activity should be within 50-60 minutes. Exercise will certainly lead to positive cardiorespiratory changes in both men and women.Cardiorespiratory endurance is associated with the development of the ability of the cardiovascular and respiratory systems to maintain and deliver oxygen to engaged muscles during long-term physical activity, as well as the ability of muscles to receive the necessary energy through aerobic processes. Physical activities have a significant impact on cardiorespiratory abilities, more precisely, there is an increase in the maximum consumption of oxygen and an increase in the personal fitness index related to the increase in respiratory capabilities. Arterial blood pressure is significantly corrected, however, it is necessary to start exercising physically for preventive purposes in time.

Key words: *HR, blood pressure, heart, VO2max, exercise, aerobics*

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Introduction

Cardiorespiratory fitness refers to the ability of the cardiovascular and respiratory systems to maintain the delivery of oxygen to engaged muscles during long-term physical activity, as well as the ability of muscles to obtain the necessary energy through aerobic processes24. Exercise can also improve cardiovascular function by adjusting to the heart and vascular system[12,16,26,30,38]. Regular physical activity reduces resting heart rate, blood pressure and atherogenic markers and increases physiological cardiac hypertrophy[6,14,41]. Exercise improves myocardial perfusion and increases high-density lipoprotein (HDL) cholesterol levels, all of which reduce stress on the heart and improve cardiovascular function in healthy and sick individuals[6,11,17,29]. The positive effect of physical activity on the cardiovascular system is reflected in: improving aerobic capacity and metabolic functions, lipid profile amplification, insulin sensitivity of immune functions, increased myocardial perfusion and fibrinolytic activity, decreased platelet adhesion due to increased prostaglandin PGI2 synthesis, increased energy expenditure (which is important for maintaining ideal body weight and healing). , as well as stress contro[l2,48]. When it comes to the type of activity, the so-called aerobic activities (sharp, even walks at a speed of about 5-6 km / h), cycling, swimming, jogging, ie. those that are based on stereotypical repetition of movements and involve large muscle groups, as well as the cardiovascular system[4,9]. One of the biggest problems of modern society is the lack of physical activity[42] where the negative connection between physical inactivity and premature mortality, coronary heart disease, hypertension, colon cancer, osteoporosis, myocardial infarction[13,25,26,34] can be clearly seen. The level of physical activity is associated with health status and in many scientific studies it has been proven that older people, engaged in aerobic exercise, are able to improve muscle strength, aerobic capacity and bone density[28,33,43]. Arterial hypertension is one of the most important risk factors for cardiovascular disease and is considered a major cause of death and disability. Therefore, proper control of blood pressure has, in addition to clinical importance, a major impact on the public health system. Measures to lower or maintain optimal blood pressure, but also the prevention of arterial hypertension is based on changes in lifestyle habits that include: weight reduction, reduced alcohol consumption, diet with a higher proportion of fresh fruits and vegetables, reduced saturated fatty acid intake, reduced salt intake, stress relief and, finally, increased body activities[27,53,54]. Although in the past few decades there has been a growing body of evidence of a significant positive impact of physical activity on maintaining and improving health status, abrupt changes in the environment over the past few centuries have led to insufficient human adaptation to

changing environmental conditions[49,55]. Also, with the advancement of technology, in terms of motorized transport, but also watching television and the expansion of the Internet, it is becoming increasingly difficult to find the time and motivation to engage in physical activity and maintain the level of fitness needed for a healthy life. Recent research indicates that about 60-70% of the population of developed countries does not achieve a minimum level of physical activity[55]. Previous research has confirmed the effect of physical activity on improving VO2max in the elderly[2]. Despite important results[23,31], the value of the moderator in the meta-regression analysis for the independent variable "age" is 50. The aim of the study is to determine the effects of aerobic activity on cardiorespiratory changes[51,52]. The primary goal will be divided into three secondary ones and will have the task of showing the separate effects of physical activities on arterial blood pressure, changes in heart rate, and the effects on functional abilities and oxygen consumption during an activity.

Method of work

Literature search

Research data for the purposes of this review were collected through electronic search engines PubMed, Scholar Google, journals in the field of sports sciences as well as relevant literature that could answer the problem posed. Keywords used for electronic search: physical activity, VO2max, arterial blood pressure, HR, cardiorespiratory fitness, aerobic activity. A descriptive method was applied in this paper.

Selection of works

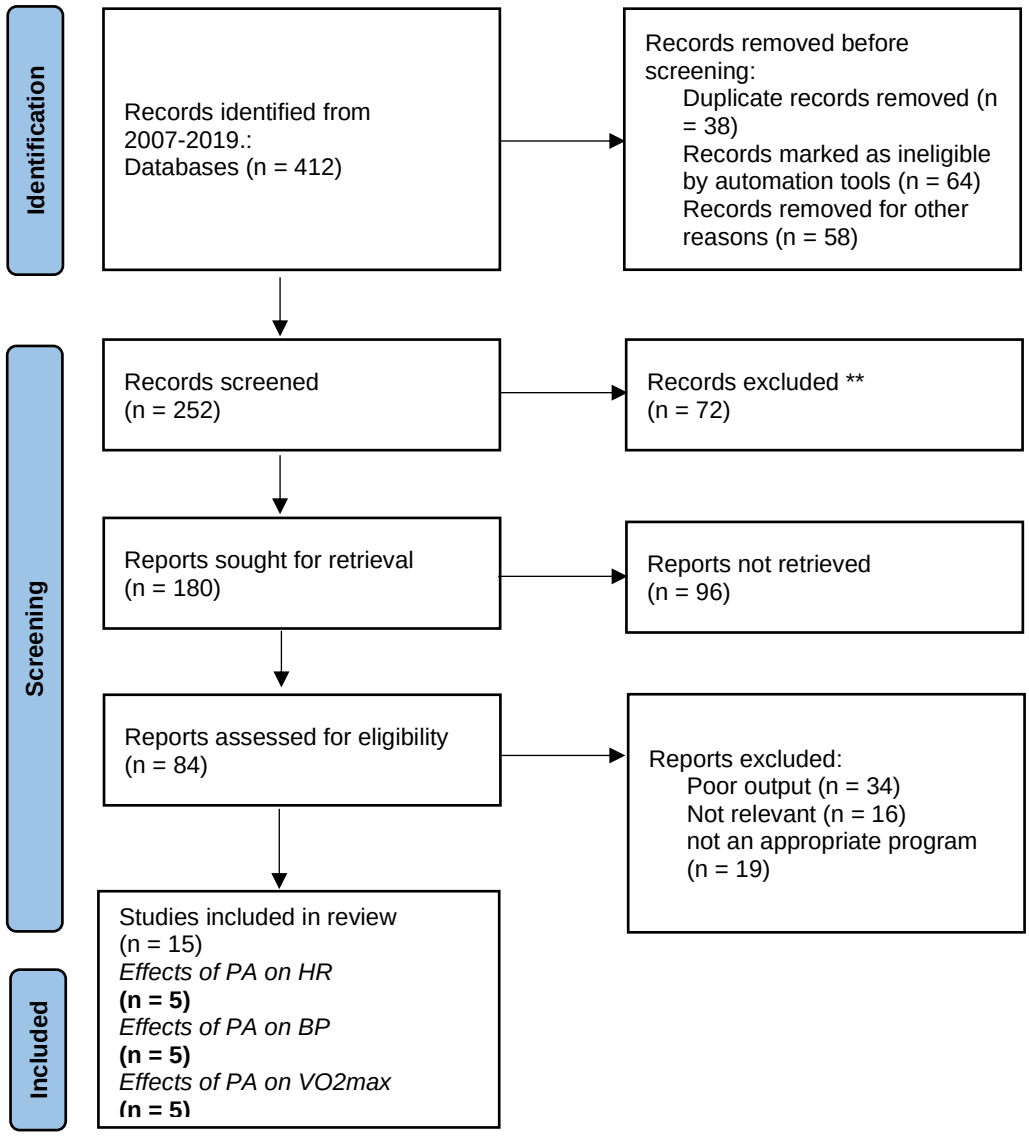
The selection of papers was determined on the basis of titles and keywords. Two selection criteria were set. The first criterion refers to the problem of aerobic activities and cardiorespiratory changes. The second criterion was the implementation of the analysis of works in the period from 2007 to 2019. Fifteen original scientific papers were selected from the mentioned time period, which were close to the subject of research and met all the criteria for further consideration. Studies in English, Serbian and other available languages are included.

Results

The search identified 412 potentially relevant studies. After removing the duplicates and reviewing the title and abstract, 84 papers remained. After reviewing the entire texts according

to the inclusion criteria, 15 papers remained, which are included in the detailed analysis and tabelar presentation. (Fig. 1).

Figure 1. Identification of studies via databases and registers



Effects of physical activity on heart rate changes

Table 1 shows the papers that dealt with the problem of the effects of physical activity on the change in heart rate. The sample of respondents included different age categories ranging from 10 to 76.8 years of age. The total number of respondents included in this survey was 289 male and female respondents. All studies were experimental in nature with a control group. The experimental groups were diverse and included activities such as aerobic exercise, pool

exercise, skipping rope, and more. The frequency of the experimental program ranged from 8 to 52 weeks.

Table 1. Effects of PA on RHR

Author (s)	N (IG)	Program / measurement	IG duration exercise	RHR change
[67]**O'Hartaigh et al., 2014**	IG = 213 76.8 yearsM / W	IG-moderate intensity / health program, not presented RHR, CG	IG-52wk, 3pw, ∑106	IG / CG = -1.4 RHR 1-2 / 69-66
[63]**Jahromi et al., 2016**	IG = 30 10-11 years W	IG- rope-jump, pulse monitor RHR CG	IG-8wk, 3pw, ∑24	IG / CG = -11.1 RHR 1-2 / 81.1-72.3
[58]**Abadi et al., 2017**	IG = 25 22.6 yearsM / W	IG- aqua-aerobic exercise, electrocardiography RHR, CG	IG- 12wk, 3pw, ∑36	IG / CG = -1.8RHR 1-2 / 73.96- 72.44
[59]**Akwa et al., 2017**	IG = 8 61.25 W	IG-aerobic exercise, automatic sphygmanometer RHR, CG	IG-8wk, 3pw, ∑24	IG / CG = -0.5 RHR 1-2 / 76.5-72
[62]**Connolly et al., 2017**	IG = 13 39 W	IG- self-paced interval and continuous training, sphygmanometer RHR CG	IG-16wk, 2pw, ∑32	IG / CG = -1.4 RHR 1-2 / 77-73

With the results stated, we conclude that the heart rate during activity increases significantly, and after the experimental program at rest there is a decrease in the total number of beats and frequency. Regular physical activity causes a decrease in resting heart rate[6,57] and such a condition seems to be inversely related to life expectancy and positively related to the cardiovascular system[1]. Aerobic activities are the best choice. The most commonly applied activities are: running, swimming, cycling, climbing, walking and in general all sports that require accelerated work of the cardiovascular and respiratory system[5].

Effects of physical activity on changes in arterial blood pressure

Table 2 shows the papers that dealt with the problem of the effects of physical activity on the change in arterial blood pressure. The sample of respondents included different age categories ranging from 20.7 to 70 years of age. The total number of respondents included in this survey was 221 male and female respondents. All studies were experimental in nature with the control group, except for the study by [68]Okamoto 2018., where acute effects were performed. The experimental groups were different and included activities such as walking, brisk walking and Nordic walking. The frequency of the experimental program ranged from 6 to 12 weeks.

Table 2. Influence of PA on arterial blood pressure

Author (s)	N (IG)	Program / measurement	IG duration exercise	mmHg change
[70]**Tully et al., 2007**	IG = 106 50.5 M	IG1-fast walking 3x IG2- fast walking 5x	IG-12wk, 3pw, ∑36	IG1 / IG2 -0.06 / -0.26
[40]**Mikalaćki et al., 2011**	IG = 30 58.5 W	IG1-Nordic walking 60-80% CG	IG-12wk, 3pw, ∑36	-11.41 p = .000 / -5.62 p = .000 E vs K p = .000
[61]**Baross et al., 2017**	IG = 36 20.7 M / W	IG1-treadmill walking, IG2-handgrip training, IG3 = IG1 + IG2, Rivatest CG	IG-6wk, 4pw, ∑24	SKP: IG3 = 127.8 ± 4.5 mmHg to 117.8 ± 3.6mmHg vs K 127.9 ± 4.3mmHg to 127.8 ± 4.3mmHg, *P* <0.001
[68]**Okamoto et al., 2018**	IG = 14 27.5 M	IG1 - 5x3-min walking 30% - 70% of maximum aerobic capacity, IG2 - continuous walking of moderate intensity for 30 minutes	Acute effects	IG1 = - 1 / 0.9 IG2 = -0.9 / 0
[69]**Park et al., 2019**	IG = 35 70 M / W	IG-walking in water, Borg scale, CG	IG-12wk, 4pw, ∑48	IG = -3 / -5.1

During exercise, an increase in heart rate and heart rate increases cardiac output, which together with a transient increase in systemic vascular resistance increases mean arterial blood pressure[10]. However, prolonged exercise can encourage a net reduction in resting blood pressure. Regular moderate to intense exercise performed 3-5 times a week lowers blood pressure by an average of 3.4 / 2.4 mmHg[56]. Although this change may seem small, recent studies show that even a decrease in systolic blood pressure of 1 mmHg is associated with 20.3 fewer (blacks) or 13.3 fewer (whites) heart failure per 100,000 person-years[50]. Therefore, a reduction in blood pressure observed when exercise was included as a behavioral intervention along with a change in diet and weight loss[32,39] could have a significant impact on the incidence of CVD -a[18,20].

Exercise has been shown to lower blood pressure (BP)[22]. However, studies reporting a reduction in blood pressure caused by chronic exercise may ignore the acute effect after exercise (i.e., hypotension after exercise [PEH]), i. lost over time.[4] Although the average reductions in ambulatory systolic blood pressure (sBP) and diastolic blood pressure (dBP) over 24 hours are 3.2 mmHg and 1.8 mm Hg, the reduction is greater in the first few hours after exercise, until measures that some subjects with hypertension achieve normal BP values[35,36].

The conclusions of a number of scientific papers on the influence of intensity on the reduction of blood pressure are contradictory. Numerous studies have shown that low-intensity physical

activity is effective or even more effective than increased-intensity physical activity[27,72]. Data and conclusions are different, and instead of the degree of load, it is recommended to estimate the intensity according to the individual heart rate[34,37]. Molmen-Hansen warns of improved functional capacity, cardiac (systolic and diastolic) function, and endothelial function by aerobic activity, thereby reducing other cardiovascular risk factors[11,12,13]. The role of physical activity in reducing blood pressure and controlling arterial hypertension is manifold useful and cannot be replaced by drug therapy. Arterial hypertension is often associated with a number of other cardiovascular conditions (e.g. , dyslipidemia or diabetes) so no drug with a usually single role in reducing just one of the diseases can replace physical activity that affects all conditions. The role of physical activity goes beyond the notion of adverse drug reactions, as well as the issue of drug adherence[22,24,26].

Effects of physical activity on changes in oxygen consumption

Table 3 shows the works that dealt with the problem of the effects of physical activity on the maximum consumption of oxygen. The sample of respondents included different age categories ranging from 20.5 to 51 years of age.

Table 3. Influence of PA on VO2max

Author (s)	N (IG)	Program / measurement	IG duration exercise	VO2max change
[71]**Shannan et al., 2008**	IG = 61 22.6 M	IG1-moderate i. IG2-vigorous i. IG3-near max. i. CG	IG-6wk, 4pw, ∑24	IG1-7.2, IG2-4.8, IG3 3.4 mL'min1-kg-1
[65]**Mikalački et al., 2017**	IG = 64 48.1 M	IG-Bruce testing protocol CG	IG-12wk, 2pw, ∑48	IG-VO2max (ml / kg / min / rel.) 27.5 (4.1) / 30.1 (4.2)
[66]**Najafipour et al., 2017**	IG = 65 51 M	IG-aerobic exercise 3x 90min, 50% –80% VO2 max CG	IG-8y, 3pw	IG / CG- Post-VO2 max 12.97
[60]**Arboleda-Serna et al., 2019**	IG = 44 31 M / W	IG1-HIIT 90-95% i. IG2-MICT 65-75%	IG-6wk, 4pw, ∑24	IG1-VO2max of 3.5 ml / kg / min IG2- 1.9 ml / kg / min
[64]**Karyono et al., 2019**	IG = 20 20.5 M	IG1- interval training, IG2- circuit training	IG-12wk, 3pw, ∑36	IG1-VO2max-43.29 / 44.78 IG2-VO2max-44.38 / 49.39

The total number of respondents included in this survey was 254 male and female respondents. All studies were experimental in nature with the control group, except for the study.With aging, there is a decrease in VO2max by 10% and after 25 to 30 years in active and inactive adults of

both sexes[17,19,44,45]. On average, men have higher VO2max than women, which is due to higher ventricular thrust, output volume, hemoglobin concentration, muscle mass, and lower body fat[8]. Studies show that there is a significantly greater increase in aerobic capacity in groups that were treated with higher intensity[3,7,15,46,47].

Conclusion

Based on an extensive literature review, we can point out the following: physical activities have a significant impact on cardiorespiratory abilities, more precisely, there is an increase in maximum oxygen consumption and an increase in personal fitness index related to increased respiratory capacity. Arterial blood pressure is significantly corrected, however, it is necessary to start exercising physically for preventive purposes in time. Due to the increase in body engagement, physical activities act in a way to reduce heart rate and optimize heart rate. Physical activity is a very important segment in improving all cardiorespiratory functions of the body.

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