INFLUÊNCIA DA ATIVIDADE FÍSICA NA MODULAÇÃO AUTONÔMICA CARDÍACA

INFLUENCE OF PHYSICAL ACTIVITY ON CARDIAC AUTONOMIC MODULATION

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RESUMO

A variabilidade da frequência cardíaca (VFC) é um método simples, não invasivo que consiste na oscilação dos intervalos entre os batimentos cardíacos consecutivos (R-R), sendo também um indicador funcional do sistema nervoso autônomo (SNA). O exercício físico estimula a aptidão cardiorrespiratória, com o que provoca alterações na função autonômica cardíaca, além de ter impacto positivo na saúde por diminuir fatores de risco na manifestação das doenças cardiovasculares. Objetivou-se identificar dados através de uma revisão integrativa da literatura sobre a influência da prática de atividade física na modulação autonômica cardíaca. A estratégia de busca foi delineada no diretório de revistas da SciELO e nas bases de dados MEDLINE e LILACS. Foram selecionados os artigos que estivessem sido publicados nos últimos cinco anos (2013 a 2017). O operador booleano AND foi utilizado para a associação dos seguintes descritores: Sistema Nervoso Autônomo; Frequência Cardíaca; Atividade física; Sistema Nervoso Simpático; Sistema Nervoso Parassimpático. Empregados os descritores mencionados, apareceram 310 artigos que faziam referência à associação dos termos procurados. Dentre estes, permaneceram 39 estudos que foram impressos para a leitura íntegra. Destes, 22 estudos foram excluídos, pois não faziam referência ao tema central da pesquisa, restando 17 artigos. Os estudos selecionados indicaram que a modulação autonômica cardíaca frente a prática de atividade física gera uma boa aptidão física que resulta em um aumento da VFC e um menor risco de desenvolver doenças cardíacas. Com algumas semanas da prática de atividade física, há um melhor balanço simpático-vagal onde há maior ativação da condução simpática após o início do exercício físico; pós-exercício há um aumento da condução parassimpática, além do que a aptidão e resistência física que se ganha com o exercício gera maior recuperação da frequência cardíaca após o exercício. A atividade física tem um impacto positivo no controle autonômico cardíaco quando é analisada por meio dos índices da VFC, nas diversas modalidades de exercício físico.

Palavras chaves: Sistema Nervoso Autônomo; Frequência Cardíaca; Atividade Física.

ABSTRACT

Heart rate variability (HRV) is a simple, non-invasive method consisting of oscillation of intervals between consecutive heart beats (R-R), and is also a functional indicator of the autonomic nervous system (ANS). Physical exercise stimulates cardiorrespiratory fitness, concomitantly, causes changes in the cardiacon function, besides having a positive impact on health by reducing risk factors in the manifestation of cardiovascular diseases. To identify data through an integrative review of the literature on the influence of physical activity practice on cardiac autonomic modulation, the search strategy was outlined in the SciELO journals directory and in the MEDLINE and LILACS databases. The study included articles published in the last five years (2013 to 2017). The Boolean operator AND was used to associate the following descriptors: Autonomic Nervous System; Heart Rate; Physical activity; Sympathetic Nervous System; Parasympathetic Nervous System. The mentioned descriptors provided 310 articles that referred to the association of the searched terms. Of these, 39 studies remained, which were printed for the whole reading. Of these, 22 studies were excluded, since they did not refer to the central theme of the research, remaining 17 articles. The selected studies indicated that cardiac autonomic modulation against the practice of physical activity generates a good physical fitness that results in an increased HRV and lower risk of developing cardiac diseases. Few weeks of physical activity provides a better sympathetic-vagal balance where there is greater activation of sympathetic conduction after physical exercise; post-exercise, parasympathetic conduction increases, in addition to physical fitness and endurance gained from the exercise generates a greater recovery of the Heart Rate (HR) after exercise. Physical activity has a positive impact on autonomic cardiac control when analyzed through HRV indexes, in the various modalities of physical exercise.

Key words: Autonomic Nervous System; Heart Rate; Physical Activity.

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INTRODUCTION

Heart rate variability (HRV) is a simple, non-invasive method that consists of oscillation of the intervals between consecutive heartbeats (R-R). Moreover, it is an effective tool to study factors of cardiovascular risks and cardiac autonomic modulation, being a functional indicator of the autonomous nervous system (ANS) 1,2.

The ANS is responsible for several homeostatic functions, including blood pressure (BP) and heart rate (HR) modulation. Several studies have shown that chronic autonomic changes are related to the development of cardiovascular diseases and an increased risk of deaths3.

High HRV values represent a good adaptation and characterize a healthy person, while their decrease indicates an abnormal adaptation of the autonomous nervous system, and are associated with morbidity and mortality, being also linked to the onset or worsening of heart diseases1,4,5.

Physical exercise provides positive changes in autonomic cardiac function and cardiorespiratory fitness. The training stimulates the predominance of parasympathetic modulation and the reduction of cardiac sympathetic modulation, as well as the largest maximum oxygen consumption and peak, modulating the negative impact of risk factors in the manifestation of cardiovascular diseases4,6-7.

Physical activity is an important factor in the prevention and treatment of cardiovascular diseases and other morbidities, besides being considered a form of body movement, held by skeletal muscle, with energy expenditure above the state of rest, with the purpose of improving the maintenance, development or recovery of physical fitness8.

This physical fitness is characterized by the practice of activities that an individual performs, originated, state of health, nutrition and, mainly, the habitual practice of exercise that can be measured by the amount of energy that a person has to make nice things in life without excessive fatigue9.

Recommendations suggest that the practice should be moderate and/or intense and continuously, lasting from 30 to 60 minutes and performed three through five times per week, being an effective way to help controlling body weight, lowering blood pressure levels, maintaining a good cardiovascular health and quality of life10.

Furthermore, the benefits of exercise are associated with better health, which has been proposed as a non-pharmacological therapeutic method suitable for maintenance and prevention of pathogens. However, the use of techniques applied to those people who want to improve their physical fitness and well-being must be careful, which involves intensity, duration and frequency of stimuli, in addition to the type of exercise used11.

The objective of this study is to identify data about the influence of physical activity practice on the cardiac autonomic modulation.

METHOD

This is an integrative review of literature; the search period occurred from September to November 2017. The search strategy was outlined in the directory of journals Scientific Electronic Library Online (SciELO) and the databases of Medical Literature Analysis and Retrieval System Online (MEDLINE) through Virtual Health Library (VHL) and Latin American and Caribbean Literature in Health Sciences (LILACS). In the definition of the descriptors, the DeCS (Health Sciences Descriptors) were used, a dictionary of indexing terms created by Bireme. The Boolean operator AND was used to associate the following descriptors: Autonomic Nervous System; Heart Rate; Physical Activity; Sympathetic Nervous System; Parasympathetic nervous system.

Then, the studies were screened by reading the abstract. For this, a spreadsheet matrix was used to control all articles found in databases, with the following discriminations: author and year, title, journal, sample, country, main findings, conclusion, database, reason for exclusion.

Some steps were adopted as the eligibility of articles and analysis of the findings to establish the included articles through a prior reading of the abstract, in order to verify its relation with the theme, and then proceed to reading of the article in its entirety.

The inclusion criteria were: 1) fully available; 2) studies in Portuguese and English; 3) published in the years 2013 through 2017. The exclusion criterion was duplicated articles and those who were not original, theses, dissertations and monographs.

The articles that remained in the sample after applying the identification and selection criteria were printed and analyzed by means of a critical reading of the study in its entirety. After this, the main approach points that these studies brought as relevance to remain in this review were highlighted, since the studies could still be removed from the research. Then, the works that presented an important outcome for this study remained in the sample, thus completing the step of eligibility and inclusion in the final results. A final outcome based on random deduction was used.

RESULTS

The mentioned descriptors provided 310 articles that referred to the association of the searched terms. The abstracts were read, and those that referred to the topic were included in the sample, which were attached in the matrix spreadsheet. After exclusion of duplicates and application of inclusion and exclusion criteria, 39 studies remained, which were printed for full reading. Of these, 22 studies were excluded for not referring to the central theme of the research, leaving 17 articles. Figure 1 illustrates the search and selection process.

Subsequently, for presentation of the results, the articles were included in Table 1, describing the following items: author and year, sample, evaluated indexes and main conclusions. Finally, a descriptive analysis of the sample and a qualitative analysis of the results of evaluations, followed by discussion of the material.
Table 1: Description of the selected articles: author and year, sample, assessed indices and main conclusions.

<table>
<thead>
<tr>
<th>Author/Year</th>
<th>Sample</th>
<th>Assessed indexes</th>
<th>Main conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAYRES et al., 2015</td>
<td>A total of 120 schoolchildren with a mean age of 11.7 ± 0.7 years were selected, using no medication.</td>
<td>rMSSD</td>
<td>Sport practice was related to a greater variability of the heart rate during rest.</td>
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<tr>
<td>KAIKKONEN et al., 2014</td>
<td>107 obese participants with a mean age of 44.5 years and a median BMI 35.7 were evaluated.</td>
<td>SDNN, HRV, VLF, LF, HF, LF/HF</td>
<td>Lifelong physical activity may reduce obesity-related health risks by improving cardiac autonomic function.</td>
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<tr>
<td>KARAKULAK et al., 2015</td>
<td>Heart rate recovery (HRR) was evaluated in 160 patients with systemic sclerosis.</td>
<td>HRV, HR</td>
<td>Systemic sclerosis was associated with a late recovery of HR after maximal exercise.</td>
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<tr>
<td>KOUIDI et al., 2013</td>
<td>11 participants that practiced exercise, 12 sedentary renal transplant patients (RT), and 12 healthy sedentary volunteers were included.</td>
<td>HRV, HF, LF/HF, FCmax, pNN50, rMSSD</td>
<td>Exercise training improves physical fitness and restores HRV in RT receptors.</td>
</tr>
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<td>LIMA et al., 2013</td>
<td>The present study analyzed the effect of a single resistance exercise on cardiac autonomic modulation in 15 patients with peripheral arterial disease (PAD).</td>
<td>LF, HF, LF/HF</td>
<td>A single resistance exercise did not alter the cardiac autonomic modulation in patients with PAD.</td>
</tr>
<tr>
<td>PALMEIRA et al., 2017</td>
<td>The sample included 1,152 male adolescents aged 14 through 19 years, who were evaluated, and HRV parameters were calculated over time.</td>
<td>SDNN, RMSSD, pNN50, LF/HF</td>
<td>Active adolescents during free time had better HRV indexes.</td>
</tr>
<tr>
<td>RAKOBOWCHUK et al., 2013</td>
<td>Twenty healthy untrained participants (n = 11 training with a heavy metabolic stress interval, n = 9 training with moderate metabolic stress interval) were included in this study, completing six weeks of training.</td>
<td>VLF, LF, HF, LF/HF, SDNN, RMSSD</td>
<td>This study demonstrates the effectiveness of interval training to improve arterial stiffness and autonomic function; however, metabolic stress was not a mediator of this effect.</td>
</tr>
<tr>
<td>ROGAN et al., 2015</td>
<td>A 40-year-old patient with severe chronic hypotension underwent exercise testing before and after kidney transplantation.</td>
<td>HR</td>
<td>It highlights the potential of the therapeutic role and exercise during the dialysis session to correct chronic hypotension, allowing patients to have greater tolerance to fluid change. It also adds to the evidence that sympathetic dysfunction is reversible with renal transplantation.</td>
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<tr>
<td>Citation</td>
<td>Text</td>
<td>Measures</td>
<td>Summary</td>
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<td>SUN et al., 2016</td>
<td>The present study investigated the autonomic recovery after an acute treadmill exercise in healthy Caucasians and Chinese. Sixty-two participants (30 Caucasians and 32 Chinese, 50% male).</td>
<td>RMSSD, LF/HF, HRV</td>
<td>The Chinese exhibited delayed autonomic recovery after an acute treadmill exercise, resulting in increased sympathetic dominance and prolonged vagal withdrawal.</td>
</tr>
<tr>
<td>YAMANAKA et al., 2015</td>
<td>In this study, 22 healthy male subjects participated as volunteers paid to examine the effects of daily exercise in the morning or at night.</td>
<td>HRV, HR, HF, LF, VL, LF/HF</td>
<td>Exercise in the morning may eventually increase parasympathetic activity, while exercise at night maintains sympathetic activity increase.</td>
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<td>OKANO et al., 2013</td>
<td>Ten trained cyclists participated in this study to evaluate the effects of transcranial direct current stimulation on the ANS.</td>
<td>HR, HRV</td>
<td>During aerobic exercise, cardiac autonomic control and cardiac efficiency of cyclists improved.</td>
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<td>DUPUY et al., 2014</td>
<td>Eleven male resistance athletes were invited to increase their training volume by 100% for 2 weeks and decreased by 50% for 1 week.</td>
<td>SDNN, RMSSD, HF, LF, LF+HF, LF/HF</td>
<td>A change in both cognitive and physical performance was found after the overload period, followed by a return to the baseline after the period of reduced training volume.</td>
</tr>
<tr>
<td>EDELHAUSER et al., 2015</td>
<td>Twenty healthy subjects were included in the study, of which 13 were women and 7 men aged between 20 and 51 years who practiced eurythmy therapy (EYT).</td>
<td>VLF, HF, LF, SDNN, DPNN</td>
<td>The practice of EYT exercise imposed rhythmic effects on cardiac autonomic regulation.</td>
</tr>
<tr>
<td>LELLAMO, et al. 2014</td>
<td>In this study, 20 patients with heart failure participated in continuous aerobic exercise for 12 weeks.</td>
<td>HR, HRV</td>
<td>The practice of physical exercise in patients with heart failure had efficacy and brought benefits, improving the quality of life.</td>
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<tr>
<td>LETI e BRICOUT., 2013</td>
<td>Ten participants were monitored for 12 weeks under different conditions: after a rest period, after a day of training, after a day of competition and after a day of rest.</td>
<td>LF, HF, LF/HF</td>
<td>The modulation-fatigue relationships of the autonomic nervous system were significant, suggesting the potential use of HRV in the monitoring and control of training.</td>
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<tr>
<td>GRANT e RENSBURG, 2013</td>
<td>The study consisted of a 12-week exercise intervention of medium and high intensity in a group of 100 male and 83 recruits of the National Defense Force of South Africa.</td>
<td>HRV, HF, LF/HF, pNN50, SDNN, RMSSD</td>
<td>Autonomic preintervention status, as specifically represented by LF, is the most important determinant of the cardiac autonomic response to an exercise intervention in a healthy study population.</td>
</tr>
<tr>
<td>CABRAL-SANTOS et al., 2016</td>
<td>Participants were 14 male volunteers, who presented neuromuscular health status with the ability to complete the study protocol.</td>
<td>HRV, RR, RMSSD, SDNN, LF, HF, LF/HF</td>
<td>The aerobic and anaerobic threshold induces different autonomic modification in physically active individuals.</td>
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</table>

RR or NN = Mean of intervals between successive QRS complexes, influenced by the ANS vagal (short term) and sympathetic (long term) branch; HR = Average heart rate influenced by the ANS vagal (short term) and sympathetic (long term) branch; RMSSD = square root of the square mean of the differences between adjacent normal RR intervals; SDNN = standard deviation of all normal RR intervals; LF = low frequency component; HF = high frequency component; LF/HF = ratio between low and high frequency components; VLF = very low frequency component; pNN50 = percentage of adjacent RR intervals with duration difference greater than 50ms;
DISCUSSION

Studies show that the HRV analysis has been used as a safe method to evaluate the effect of exercise on heart activity. Through the HRV indexes, there is better cardiac autonomic modulation in individuals practicing physical activity, indicating that the exercise causes positive effect on cardiac activity. In agreement with this, diverse populations benefit from this practice regarding reduction in the chances of developing diseases and complications of cardiovascular diseases\(^\text{12}\).

In its general shape, exercise causes a state of alert and is associated to an increased sympathetic activity and a decreased parasympathetic activity, resulting in an increased cardiac contractility, heart rate, volume of O\(_2\) and blood pressure\(^\text{13, 14}\). Physical training provides improvement of neural regulation on the control of the cardiovascular system, causing greater parasympathetic activity stimulus when the individual is at rest\(^\text{15, 16}\).

Evaluating the aerobic fitness and HRV in obese adults, physical activity was positive, suggesting that physical exercise throughout life can be important for preventing diseases associated with obesity. With this, the resistance exercise has an effect on the life of patients with peripheral artery disease, improving the ability to walk, quality of life and muscular strength\(^\text{17, 18}\). Therefore, exercise has a positive role in stimulating the improvement of the physical capacity, presenting a significant and positive relation in the quality of life\(^2\).

The exercise can be used to evaluate other stimuli added to this practice. The transcranial brain stimulation of direct current was applied to experienced cyclists with 10 through 11 years of training. The authors reported that the maximum power output improved by 4%. By analyzing the HRV, the researchers suggest that there was a faster vagal withdrawal, causing a better stimulus by sympathetic ANS, which results in a more intense physical activity and with greater resistance\(^\text{19}\).

Therapies with body movement provide a better regulation and modulation of heartbeats and may vary according to the frequency of these activities and types of movements. This is evidenced in studies that have identified that oscillations of the HRV increase during Eurythmy therapy, mainly elevation of the parasympathetic stimulation, resulting from a better adaptation of the ANS and vagal control on bodily movements stimulation\(^\text{20}\).

One way of evaluating how physical activity can promote cardiovascular health is assessing the HR recovery. With this, researches show that regular practice of physical activity leads the individual to have a more pronounced HR recovery when comparing the same indexes in the weeks before sedentary people beginning the practice. In this way, there is a greater physical resistance, decreasing the ability to overload the heart in other activities\(^\text{21, 22}\).

In agreement with this, the Maximum Volume of Oxygen (maxVO\(_2\)) may be one of the contributors as a measure of this HR recovery, since, in the adaptation to exercise, maxVO\(_2\) increases as athletes or individuals perform constant physical activity. In this context, a study evaluated 183 volunteers (18-22 years) in exercise intervention with a 2.4km path and, after

Figure 1. Flowchart describing the studies selection, inclusion and exclusion steps.
12 weeks of practice, they were reassessed, presenting an increased maxVO2, resulting in a better HR recovery23.

For the practice of physical exercises, some groups have to maintain a stronger control over heart functioning through the HR perception. Individuals with Chronic Heart Failure (CHF) receive exercise prescription based on the HR response to exercise, with this, a study analyzed the HRV in participants with CHF during physical exercise based on perceived effort. The authors concluded that the practice is beneficial for this group, as well as it can be done in the long term without causing adverse/negative cardiac abnormalities24.

In this way, physical activity generally exerts a positive effect on the heart activity, since the studies identified best autonomous nervous system action on the heart activity with the presence of physical activity.

CONCLUSION

The different ways of practicing physical activity have a positive impact on the health of the heart, both on the cardiac autonomic modulation as other factors that may contribute to heart disease. The analysis of the HRV indexes identifies gradual improvement during and after the process of adaptation to the practice of exercise.

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