1 INTRODUCTION

Exercise can be characterized as a sequence of organized movements with a specific purpose, namely to increase overall athletic or functional performance (MCARDLE; KATCH; KATCH, 2016).

The regular practice of physical exercises has been associated with health promotion and widely indicated for contributing significantly to the control of body adiposity, for its benefits in the regulation of several physiological functions, and also for helping in the treatment of several cognitive, motor, and psychological diseases (FERREIRA et al., 2020).

According to McArdle, Katch and Katch (2016), physical activity is understood as any movement caused by muscle contraction that results in energy expenditure above resting level. It is already evident in the literature that its regular practice is directly associated with disease prevention and improvement of health and quality of life.

The lack of physical activity, in turn, has been caused mainly by changes in people's routine due to the facilities provided by technological advances of easy access, such as the use of cars, inactive leisure through cell phones, video games, computers, and etc. The lack of physical activity and exercise is seen as one of the main risk factors for the onset of chronic noncommunicable diseases (NCDs) (FARIAS JÚNIOR et al., 2012).

In 2016 the Brazilian Society of Cardiology found that diseases in the vascular system are among the leading causes of increased mortality rates in the world and can have numerous factors such as age, overweight, obesity, high consumption of sodium and alcohol, especially the lack of physical activity (SBC, 2016).

The World Health Organization (WHO, 2018) dictates that some activities such as running, cycling, walking, and playing sports, should be practiced every day for the body to have a better
functional performance preventing diseases such as hypertension, diabetes mellitus, depression, among others, and also helps in the body's energy balance and weight control.

Physical Education at school, throughout the student's education, proposes body practices in the cultural perspective of movement and these bring influences on the promotion and maintenance of health as well as the awakening of critical and reflective sense of general knowledge addressed at school (LUCIANO et al., 2016).

High school is considered the final phase of education in which students put into practice everything that was learned in previous years, this phase of education coincides with adolescence, a period in which the daily routine of these adolescents is greatly affected by social, professional, cultural and school factors, which contributes to the increase in physical inactivity rates (BRASIL, 2017). As a preventive aspect and strategy to combat physical inactivity, it is recommended that the daily practice of physical exercise is an effective way to prevent diseases such as hypertension and irregularities in cardiac autonomic modulation.

Sedentary lifestyle is increasingly marked in our society, especially among adolescents. Bundy et al. (2017) point out that the prevalence of obesity associated with sedentary lifestyle in adolescence can induce severe metabolic changes and increase the risk of cardiovascular disease in adulthood.

There are several biomarkers used to trace the health profile of an individual; these are tools that make it possible to identify an adverse condition before damage to health is evident. The study by Ricci-Vitor (2016) shows that poor eating habits in adolescence can trigger irregularities in health biomarkers, especially those associated with NCDs.

Heart rate variability (HRV) can be highlighted as an important biomarker that can quantitatively identify the autonomic balance. The HRV can be defined as a change in the interval between consecutive heartbeats. In this context, the autonomic balance or autonomic modulation is the term given to the control of the sympathetic and parasympathetic nervous systems. The dysfunction of these systems can cause changes in myocardial reflexes, insufficiency in the function of cardiovascular adaptation, below average physical performance, contractile myocardial dysfunction, as well as arrhythmias and sudden death (SANTOS, 2017).

Adherence to regular physical exercise has been shown to be an efficient way to increase HRV parameters, in adolescents studies point out a beneficial association between physical exercise outside the school context and higher HRV (CAYRES et al., 2015; NASCIMENTO et al., 2019).

Nevertheless, although the benefits of physical exercise are known, there is still a doubt as to whether cardiac autonomic modulation is related to exercise in adolescence.
2 OBJECTIVE

To analyze the scientific discussions regarding the impact of exercise on cardiac autonomic modulation in schoolchildren.

3 METHODOLOGY

This paper is the result of an integrative review, which according to Souza, Silva and Carvalho (2010), is characterized as a research that allows the aggregation of various information to understand the analyzed phenomenon, enabling the synthesis of concept definitions, review of theories and evidence, by considering the theoretical and empirical literature approaches as a way to maintain reliability during the analysis.

As for the classification of the objectives, the research is exploratory, as it seeks to familiarize the researcher with the problem in order to make it more explicit, and explanatory, because the research also seeks to explain the impact that physical exercise has on the autonomic modulation of adolescents (GIL, 2002).

To obtain the articles, searches were made in MEDLINE, LILACS, SciELO, and Adolec, Elsevier indexes using the following health descriptors: physical exercise; autonomic nervous system; adolescent. Inclusion criteria included original articles that related physical exercise with cardiac autonomic modulation, used adolescents as the target audience, and studies carried out in a school setting. Exclusion criteria included review studies, theses and dissertations, and duplicate articles. With the initial search in the databases, it was possible to find a total of 63 studies. We found 45 articles in MEDLINE, 4 in LILACS, 3 in SciELO, 10 in Adolec and 1 in Elsevier. The location and selection of studies are described in Figure 1. After applying the inclusion and exclusion criteria, eight articles were selected for reading in full. Of these eight, six were selected to be included in the review sample.

Figure 1 - Flow chart of the integrative review steps

4 DEVELOPMENT

4.1 RESULTS AND DISCUSSIONS

Table 1 shows the papers included for review, identifying the authors, journal, year, title, objectives, sample, and conclusions.

<table>
<thead>
<tr>
<th>Authors, journal and year</th>
<th>Title</th>
<th>Goal</th>
<th>Sample</th>
<th>Conclusions</th>
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</thead>
<tbody>
<tr>
<td>CAYRES et al., 2015 Paulista Journal of Pediatrics</td>
<td>Sports practice is related to parasympathetic activity in adolescents</td>
<td>To analyze the relationship between sports practice, physical education classes, habitual physical activity and cardiovascular risk in adolescents</td>
<td>120 adolescents enrolled in schools in the municipality of Presidente Prudente</td>
<td>Sports practice was related to a higher heart rate variability at rest</td>
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<tr>
<td>PALMEIRA et al., 2017 Paulista Journal of Pediatrics</td>
<td>Association between leisure-time and commuting physical activity with heart rate variability in adolescent males</td>
<td>To investigate the association between heart rate variability (HRV) parameters and leisure-time physical activity and commuting in adolescent males</td>
<td>1,152 adolescent males aged 14 to 19 years, enrolled in schools classified as small, medium, and large.</td>
<td>Leisure-time and commuting physical activities were associated with better HRV, and such associations were strengthened when adolescents had maintained physical activity for more than six months.</td>
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<tr>
<td>FARAH et al., 2017 Pediatric Cardiology,</td>
<td>Physical activity and heart rate variability in adolescents with abdominal obesity</td>
<td>To analyze the association between physical activity and heart rate variability (HRV) in adolescents with and without abdominal obesity.</td>
<td>High school students between 14 and 19 years old</td>
<td>Higher leisure-time physical activity, but not total and commuting physical activity levels, was associated with improved HRV in adolescents with abdominal obesity</td>
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<tr>
<td>PASCHOA; NEVES; DONATO, 2018 Journal of Medical Sciences</td>
<td>Heart rate and autonomic modulation of the heart in obese preadolescents before, during and after a short Aerobic Training Program</td>
<td>To investigate whether a short aerobic training program could cause modification in resting heart rate and changes in cardiac autonomic modulation in obese preadolescents.</td>
<td>The study involved fifteen sedentary obese preadolescents aged 9 to 12 years, enrolled in public schools in the northwest region of Campinas (SP).</td>
<td>Short-duration aerobic training (12 sessions), at the intensity in which it was applied, was not sufficient to promote significant reduction in resting heart rate and changes in the pattern of cardiac autonomic modulation.</td>
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<tr>
<td>NASCIMENTO et al., 2019 Brazilian Journal of Sports Medicine</td>
<td>Sedentary lifestyle in adolescents is associated with impaired cardiovascular autonomic modulation</td>
<td>To evaluate the association between physical inactivity and heart rate variability (HRV) in adolescents</td>
<td>129 adolescents between the ages of 15 and 17</td>
<td>Physically active life was associated with better cardiovascular autonomic modulation in adolescents</td>
</tr>
<tr>
<td>ZANUTO et al., 2020 Journal of Pediatrics</td>
<td>Is physical activity associated with resting heart rate in boys and girls? Representative study controlled for confounding factors</td>
<td>To investigate the relationship between different domains of physical activity and resting heart rate (RHRF) in boys and girls</td>
<td>1,011 adolescents, between 10 and 17 years old</td>
<td>Physical activity in the domain of sports practice and total physical activity were related to low HRRP in both genders, while occupational physical activities were associated with HRRP only in boys</td>
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In the studies by Cayres et al. (2015), Farah et al. (2017), Palmeira et al. (2017) and Zanuto et al. (2020), it was found that adolescents practicing sports activities outside the school environment had higher HRV and lower resting heart rate values, another domain of physical activity that is well associated with higher HRV, are the physical activities done during leisure time. The study of Piccolo et al. (2019) highlights leisure time as being important for inducing positive changes in cardiac autonomic modulation.

Physical activity as leisure during adolescence can be an effective way to reduce the risks of comorbidities in this period of life, however, to stimulate adherence to the practice of physical activity, some aspects should be taken into consideration such as the encouragement of parents, physical education teachers and the availability of safe places close to home suitable for such practices. (FARIAS JUNIOR et al., 2012)

According to Lima et al. (2011) sessions promote beneficial changes in cardiac autonomic modulation, which can be enhanced when these activities are performed at higher but controlled intensities. Other beneficial aspects of the practice of strength training by adolescents that can be listed are the increase in muscle mass, strength gain, power, muscular endurance, physical conditioning, regulation of adiposity indexes and also numerous benefits to mental health (PINTO; PEREIRA, 2021). Encouraging the practice of resistance exercises in this phase of life prevents the onset of numerous motor and metabolic diseases in adulthood and old age.

A study by Farah et al. (2017) points out that physical activities of displacement (AFD) such as walking or cycling, are not enough to cause changes in the parameters of HRV in obese adolescents, the authors cite that this may occur due to the low intensity and volume of time of these activities are not enough to cause significant impacts on cardiac autonomic modulation. Corroborating this, Farah et al. (2013) point out that the practice of aerobic exercises at low intensity, practiced for six months, are not sufficient to induce significant changes in cardiac autonomic modulation, but on the other hand it is found that the vigorous practice of these activities induces additional benefits on cardiovascular health, inducing an improvement in cardiac autonomic modulation in obese adolescents.

Another study that provides similar data is that of Santana et al. (2019) in which submaximal aerobic exercise, in overweight and obese adolescents, was found to have no significant impacts on cardiac autonomic modulation.

On the other hand, DFA when done by non-obese adolescents, Palmeira et al. (2017) point out that DFA practiced for more than six months, has a relationship with higher HRV rates, enabling us to understand that in the medium and long term, the practice of DFA can bring benefits to the cardiac system of non-obese adolescents.

Thus, it is noticeable that the intensity at which physical exercise is practiced is an important factor for its impact on health to be significant or not. Ferreira et al. (2020) emphasize the importance
of practicing physical exercises with adequate intensity and volume of time, so that benefits such as reducing NCDs and the risk of death from cardiovascular diseases are significant to health. This is corroborated by Lima et al. (2011) when they point out in their results that exercises performed at higher intensities enhance the parameters of cardiac autonomic modulation in adolescents when compared with exercises performed at an intensity considered moderate.

These data reinforce the idea that more intense physical exercise provides greater benefits to the cardiovascular health of adolescents, due to its broad influence on the cardiac system, which is in agreement with the aforementioned studies.

A study that analyzed the effects of exercise regarding the time of practice was that of Paschoa, Neves, and Donato (2018), in which they point out that moderate intensity physical training, when done for a short period (12 sessions) did not cause significant changes in resting heart rate and cardiac autonomic modulation.

In contrast, Ricci-Vitor (2016) obtained positive results in cardiac autonomic modulation as well as a reduction in resting heart rate, with the application of moderate physical exercise in adolescents, but with a longer time of application (36 sessions), a fact that highlights the benefits of physical exercise practice in the medium and long term.

Thus, it can be seen that the time of practice not only determines the positive impacts on autonomic modulation, but also enhances them over time. The study by Palmeira et al. (2017) found that adolescents who have been physically active for more than six months have better HRV parameters when compared to adolescents who have been physically active for less than six months.

When talking about the impact of exercise on adolescents who are overweight or obese, in the studies by Farah et al. (2017) and Palmeira et al. (2017), it was found that routine exercise caused significant changes in HRV parameters. Both overweight and obesity are of multifactorial origin and can have biological, psychological, and socioeconomic influences. They can be characterized by increased weight in relation to height and uncontrolled increase in adipose tissue respectively (WHO, 2018).

In Brazil, about 50% of the population is overweight, and of children and adolescents between 10 and 19 years old, about 17.45% are overweight or obese (ABESO, 2016). These data show the relevance of encouraging the practice of daily physical exercise, as well as the importance of adopting healthy habits.

Thus, children and/or adolescents understand the value and importance of something when it is taught to them, so it is important that parents set examples and provide incentives for regular exercise, good nutrition, and a healthier lifestyle. Teaching these values is necessary to contribute more effectively to changing the alarming increase in obesity and overweight in children and adolescents, and consecutively in reducing the related morbidity and mortality rates.
The study of Chen et al. (2012) pointed out the need for obese adolescents to practice physical activity in their daily lives as a health regulator of body adiposity. Other findings in the studies of Chen et al (2012) and Ricci-Vitor (2016) show that physical activity promotes improvement in the regulation of sympathetic and parasympathetic function and consequently in resting HRV of adolescents, as well as its regular practice is able to cause the modification of the category of adolescents classified as obese to overweight.

In this sense, it is worth emphasizing the importance of physical activity during adolescence as it is an important agent in the regulation of health indicators and in the prevention of diseases both during adolescence and adulthood.

When talking about the level of physical activity and how it impacts the health of adolescents, the studies of Cayres et al. (2015), Farah et al. (2017), Palmeira et al. (2017), Nascimento et al. (2019) and Zanuto et al. (2020) show that physical exercise is linked to better HRV parameters and benefits in cardiac autonomic modulation. The authors also point out the need for adolescents to have physical exercises integrated into their daily lives, since its regular practice enhances its benefits to cardiovascular health.

The maintenance of physical activity levels besides being indicated by the authors Cayres et al. (2015), Farah et al. (2017) and Nascimento et al. (2019), is considered essential in adolescence, since the lack of physical activity in adolescents' daily lives becomes a very prevalent risk factor for the onset and worsening of cardiovascular diseases.

It is worth noting that physical inactivity is one of the most important risk factors for the development of cardiovascular diseases, having a higher prevalence than other risk factors such as: obesity, overweight, smoking, alcoholism and others (SBC, 2016).

Regular physical activity prevents risk factors such as overweight and obesity, and is also a non-pharmacological treatment mechanism for NCDs and prevention for cardiovascular disease (CAMPOS et al., 2019).

Zaffalon Junior (2018) point to physical exercise as capable of promoting improved functionality of the cardiovascular system. The Brazilian Society of Cardiology (2016) indicates the regular practice of physical exercise for both the treatment and prevention of cardiovascular diseases.

The studies by Farah et al. (2017) and Zanuto et al. (2017) indicated the need to expand the encouragement of sports practices in order to promote more health for adolescents.

In this sense, to encourage the maintenance of physical activity levels in adolescence, it is possible to consider the Physical Education curriculum component as an efficient mechanism. Farias Junior et al. (2012) point out the direct relationship between the frequency of students in physical education classes and their level of physical activity.
Corroborating this, Sousa, Oliveira, and Zaffalon Junior (2019) indicate Physical Education classes as health prevention measures, since through it it is possible to encourage the practice not only of physical exercises, but also to stimulate the change of habits that will contribute to the students' quality of life, since they enable the inclusion of physical exercise in the weekly routine of adolescents.

Considering that school life spans throughout childhood and youth and becomes influential in social, ethical, body and intellectual development, the school through physical education classes becomes a suitable place to encourage the adoption of healthy habits and health care, aiming to prevent obesity and consecutively several NCDs. In this sense, the school becomes a useful institution for the development of educational programs aimed at teaching good eating habits, physical exercise, self-care and other health-related aspects (PEDRAZA et al., 2018).

After compiling and analyzing the selected studies, it can be seen that physical activity and healthy lifestyle in adolescence generates positive responses in cardiac function, decreases the risk of overweight, provides increased muscle mass and bone density, in addition to improving metabolic indicators and increased lung capacity. It is understood then that the school, especially the curricular component of Physical Education, is a very important mechanism for promoting the practice of physical activities, either by promoting the regular practice of exercises or encouraging the practice of physical activities outside the school environment, as a way to influence and therefore transform the daily lives of adolescents.

5 CONCLUDING REMARKS

This research aimed to verify the scientific discussions regarding the impact of exercise practice on the cardiac autonomic modulation of schoolchildren. By analyzing the studies obtained through this research, it was possible to understand the several ways in which physical exercise impacts the cardiac autonomic modulation of adolescents. The study found that physical exercise, when practiced regularly, causes beneficial changes in cardiac autonomic modulation, as well as becoming a mechanism to combat risk factors such as sedentarism, overweight, and obesity.

With the analysis of the data obtained through the survey, it is possible to reinforce the need to add the practice of physical exercises in the daily routine of adolescents. In this sense, the curricular component of Physical Education is indicated as a mechanism for promoting physical exercise and encouraging changes in the habits of adolescents.

In summary, the development of new studies that evaluate not only the impacts of physical exercise practice on cardiac autonomic modulation in adolescents, but also the types of exercise practiced is necessary, considering that factors such as intensity, time of practice and total volume of training sessions influence the parameters of HRV and cardiac autonomic modulation. It is also suggested that these studies be carried out in the school environment, since it is possible to find a
diversity of sports practices, whether they are in the school environment or during the students' leisure time.
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