

Effect of physical training on the blood pressure of adolescents with obesity

Efeito do treinamento físico na pressão arterial de adolescentes com obesidade

Efecto del entrenamiento físico en la presión arterial de adolescentes con obesidad

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ABSTRACT

Objective: To systematically review the results of studies that analyzed the effects of physical training on the blood pressure of obese adolescents.

Data sources: A systematic review of randomized clinical trials was performed and examined the effect of physical training on the blood pressure of obese adolescents, published in journals indexed at PubMed/Medline, Lilacs, SciELO, and ISI Web of KnowledgeSM databases. Studies that evaluated adolescents published until 2010 and that had a Control Group were included.

Data synthesis: Eight studies met the inclusion criteria. Two of them used strength exercises combined with aerobics, while six used only aerobics. Five studies used complementary intervention, especially nutritional. Four studies found decreased systolic blood pressure in the Training Group compared to Controls, together with the reduction in body mass. All studies that found a reduction in systolic blood pressure used aerobic exercises from 12 to 24 weeks three to six times per week, lasting 50 to 90 minutes, and with intensity between 55 and 75% at the maximum heart rate.

Conclusions: The effect of physical training on the systolic blood pressure of obese adolescents is controversial. However, the reduction in systolic blood pressure seems to occur with aerobic training programs, that also reduce body mass.

Key-words: adolescents; obesity; blood pressure; exercise.

RESUMO

Objetivo: Descrever, por meio de uma revisão sistemática, os efeitos do treinamento físico sobre a pressão arterial em adolescentes com obesidade.

Fontes de dados: Recorreu-se à revisão sistemática de ensaios clínicos randomizados que analisaram o efeito do treinamento físico sobre a pressão arterial de adolescentes obesos, publicados em periódicos indexados nas bases de dados PubMed/Medline, Lilacs, SciELO e ISI *Web of Knowledge*SM. Foram incluídos os estudos que avaliaram adolescentes publicados até 2010, e que possuíam Grupo Controle.

Síntese dos dados: Oito estudos atenderam aos critérios de inclusão. Dois deles utilizaram exercícios de força combinados com aeróbios, enquanto seis empregaram apenas os aeróbios. Cinco estudos utilizaram intervenções complementares, sendo a nutricional a mais frequente. Quatro estudos observaram redução da pressão arterial sistólica no Grupo Exercício comparado ao Controle. Nesses quatro estudos, além da redução da pressão arterial, notou-se diminuição da massa corpórea. Todos aqueles que verificaram redução da pressão arterial utilizaram 12 a 24 semanas de exercícios aeróbios, três a seis sessões semanais, com duração de 50 a 90 minutos e intensidade entre 55 e 75% da frequência cardíaca máxima.

Conclusões: O efeito do treinamento físico na pressão arterial de adolescentes obesos é controverso. A redução da pressão arterial parece ocorrer com programas de treinamento aeróbios que promovam também a redução da massa corpórea.

Palavras-chave: adolescentes; obesidade; pressão arterial; exercício.

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RESUMEN

Objetivo: Describir, mediante una revisión sistemática, los efectos del entrenamiento físico sobre la presión arterial en adolescentes con obesidad.

Fuentes de datos: Se recurrió a la revisión sistemática de ensayos clínicos aleatorios que analizaron el efecto del entrenamiento físico sobre la presión arterial de adolescentes obesos, publicados en periódicos indexados en las bases de datos PubMed/MedLine, LILACS, SciELO e ISI Web of knowledgeSM. Se incluyeron los estudios que evaluaron a adolescentes, publicados hasta el año de 2010 y que poseían grupo control.

Síntesis de los datos: Ocho estudios atendieron a los criterios de inclusión. Dos de ellos utilizaron ejercicios de fuerza combinados con aeróbicos, mientras que seis emplearon solamente ejercicios aeróbicos. Cinco estudios utilizaron intervenciones complementarias, siendo la intervención nutricional la más frecuente. Cuatro estudios observaron reducción de la presión arterial sistólica en el grupo ejercicio comparado al control. En esos cuatro estudios, además de la reducción de la presión arterial, se notó disminución de la masa corporal. Todos los estudios que verificaron reducción de la presión arterial utilizaron de 12 a 24 semanas de ejercicios aeróbicos. El programa de entrenamiento tuvo lugar con tres a seis sesiones semanales con duración de 50 a 90 minutos e intensidad entre 55 y 75% de la frecuencia cardíaca máxima.

Conclusiones: El efecto del entrenamiento físico en la presión arterial de adolescentes obesos es controvertido. Sin embargo, la reducción de la presión arterial parece ocurrir con programas de entrenamiento aeróbicos que promueven también la reducción de la masa corporal.

Palabras clave: adolescentes; obesidad; presión arterial; ejercicio.

Introduction

Obesity is one of the most prevalent diseases among adolescents⁽¹⁾, ranging from 6 to 12% in Brazil, depending on the geographic location⁽²⁻⁵⁾. Hypertension, the main risk factor for cardiovascular disease, is also highly prevalent in adolescents, mainly the obese ones⁽⁶⁻¹³⁾. A recent study⁽⁹⁾ showed that the prevalence of hypertension is six fold higher in obese adolescents compared to normal weight children. Thus, the treatment of these adolescents should include weight control, as well as the reduction of blood pressure^(10,17-22).

Physical training is considered an important component of obesity treatment in adolescents. Several studies have shown that adolescents who undergo systematic physical training show improvement in physical fitness⁽²³⁾, body composition⁽¹⁴⁾ and decrease in inflammatory markers^(24,25). In contrast, the effects of physical training on the blood pressure of this population remain controversial^(20-22,26-32). While some studies have observed a reduction^(19,28,30,31) in systolic blood pressure, in others it remained unchanged^(20-22,29). Studies that analyzed the effects of physical training in diastolic and mean blood pressure have also shown controversial results^(19-22,28-31).

In this context, it is necessary to summarize the data about the effects of physical training on the blood pressure of obese adolescents, aiming to identify the factors related to such differences. Therefore, this study aimed to analyze, using a systematic review, the effects of physical training on the blood pressure of obese adolescents.

Methods

The main outcome of this review was the change in the blood pressure of obese adolescents after a physical training program. We performed a systematic review of the original studies published in journals indexed in PubMed/MedLine (National Library of Medicine), LILACS (Literatura Latino-Americana e do Caribe em Ciências da Saúde), SciELO (Scientific Electronic Library Online) and ISI Web of knowledgeSM electronic databases, which analyzed the effects of physical training on the blood pressure of obese adolescents.

The keywords used in the electronic research were defined in consultation to the Medical Subject Headings (MeSH) on the U.S. National Library of Medicine (NLM) website and to the DeCS – Descriptors in Health Sciences (Descritores em Ciências da Saúde) in the Health Virtual Library (Biblioteca Virtual em Saúde – BVS). The keywords were divided into four blocks, and then combined, as shown in Figure 1.

The electronic search in the databases was performed using the combination of the keywords and the application of limits, with the inclusion of studies that: evaluated subjects between 10 and 18 years old; were published up to 2010; were performed in humans; were randomized clinical trials; and were controlled.

By reading the titles and abstracts retrieved in the first search, we included studies that met the following criteria: the sample was constituted of obese adolescents, regardless of whether the studies included other age groups; the blood pressure was measured; and the study included a non exercise control group.

In the following step, we performed the full reading of the articles and data extraction. In this step, besides the outcome, we also extracted the data that could have affected the main outcome, such as the sample characteristics, the body mass, the exercise protocol and complementary interventions. We also performed the analysis of the studies quality using the PEDro score⁽³³⁾. This score consists of 11 questions, with scores ranging from zero (minimum) to ten (maximum).

All the steps (electronic search in the databases, selection and evaluation of the potential studies, data extraction and analysis of the studies quality) were performed by two independent investigators, and the results of each phase were compared by a third investigator, who evaluated the agreement between the pairs. If disagreements were found, the third investigator was responsible for the final analysis.

Results

We identified 106 studies (Figure 2) in the PubMed/MedLine database, 103 in LILACS, 77 in ISI and none in SciELO. From these, only 15 evaluated the effects of physical training on the cardiovascular variables of obese adolescents^(17-22,26-31,34-36). Four of these studies were excluded for the lack of a control group^(26,27,35,36) and three others for not evaluating the effects of physical training on blood pressure^(17,18,34).

Table 1 shows the main characteristics of the studies included in this review. From the eight studies included, six were published since 2000^(19-22,28,29). The sample size ranged from 19 to 443 adolescents aging from 10 to 17 years old. The mean body mass ranged from 29.2 to 34.4kg/m². The PEDPro score ranged from 4 to 7.

Five studies used some kind of complementary intervention^(19,28-31), with the dietary intervention being the most common (Table 2). The duration of training ranged from 8 to 48 weeks. Regarding the exercises protocol, two studies used strength exercises combined with aerobic exercises^(21,22), while six used aerobic exercises only. Three of these studies combined walking with sporting activities^(22,28,30). Most studies used a three weekly sessions schedule lasting from 40 to 90 minutes each, with intensities from 55 to 95% of the maximum heart rate.

Table 3 shows the results of the effects of training on blood pressure. Four studies observed a decrease in the systolic blood pressure in the training group compared with the control group^(19,28-30), while four other studies did not show any difference^(20-22,29). Two studies^(29,30) observed a decrease in the diastolic pressure and one study⁽³⁰⁾ showed a decrease in the mean blood pressure in the training group when compared with the control group. The four studies that showed a decrease in the systolic blood pressure also found a decrease in body mass.

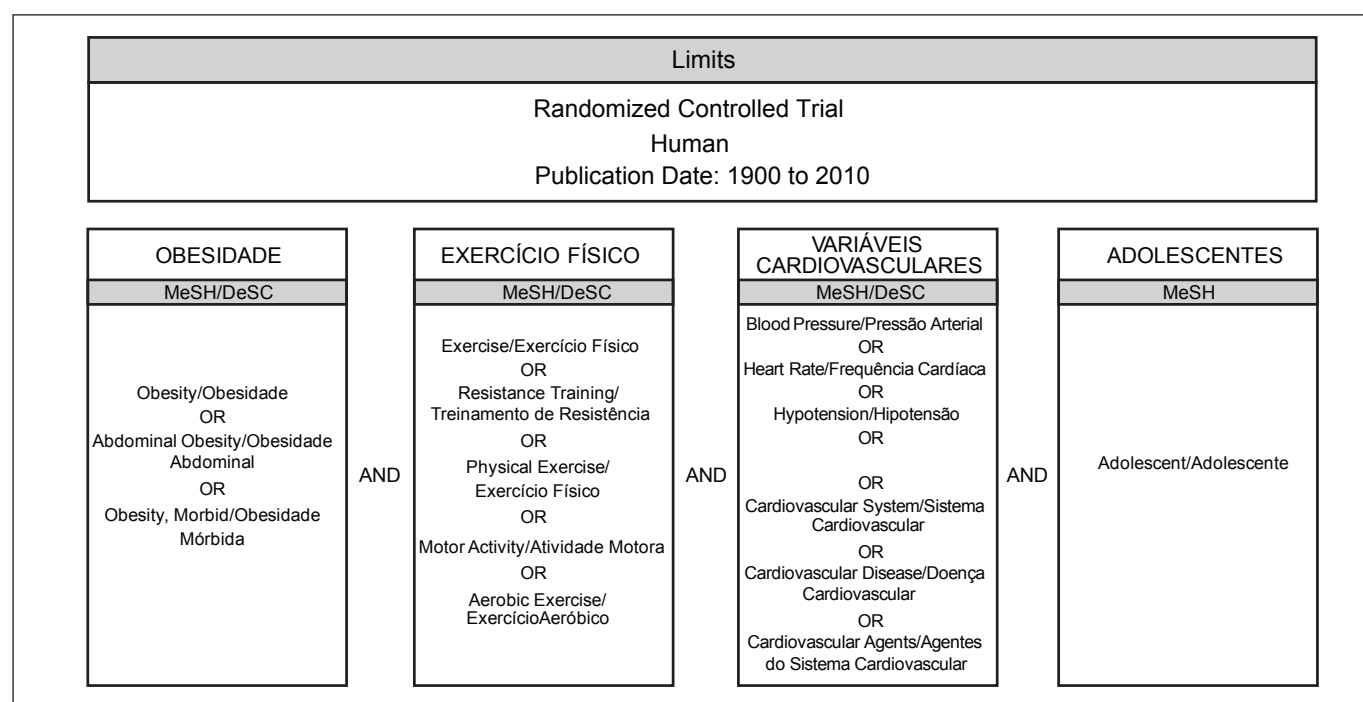


Figure 1 - Keywords used for search

Discussion

The main findings of this study were: the effects of physical training on the blood pressure of obese adolescents are controversial, the decrease in the blood pressure resulting from physical training seems to occur concomitantly with the reduction in the body mass; and the studies that observed a decrease in the blood pressure with physical training used an exercise schedule consisting of three to six weekly sessions of aerobic exercises lasting from 50 to 90 minutes each, with intensity of 55 to 75% of the maximum heart rate, and training duration ranging from 12 to 24 weeks.

For this review, we performed a literature search in the PubMed/MedLine, LILACS, ISI and SciELO databases, which represent the main sources of original scientific data in

health sciences. The search showed that articles on the theme were only identified at PubMed/MedLine and ISI. These results emphasize that original information on the effects of physical training on the blood pressure of obese adolescents are not conveyed in the Latin American literature, so that professionals who are interested in obtaining information on the subject must necessarily consult the databases in the English language.

The results of the studies that analyzed the effects of physical training on the blood pressure of obese adolescents showed great controversy. Of the eight studies that evaluated the effects of physical training on the systolic pressure, only four found a significant decrease. Likewise, only some of the studies that evaluated the effects on the diastolic and mean pressure showed a reduction of these variables in response

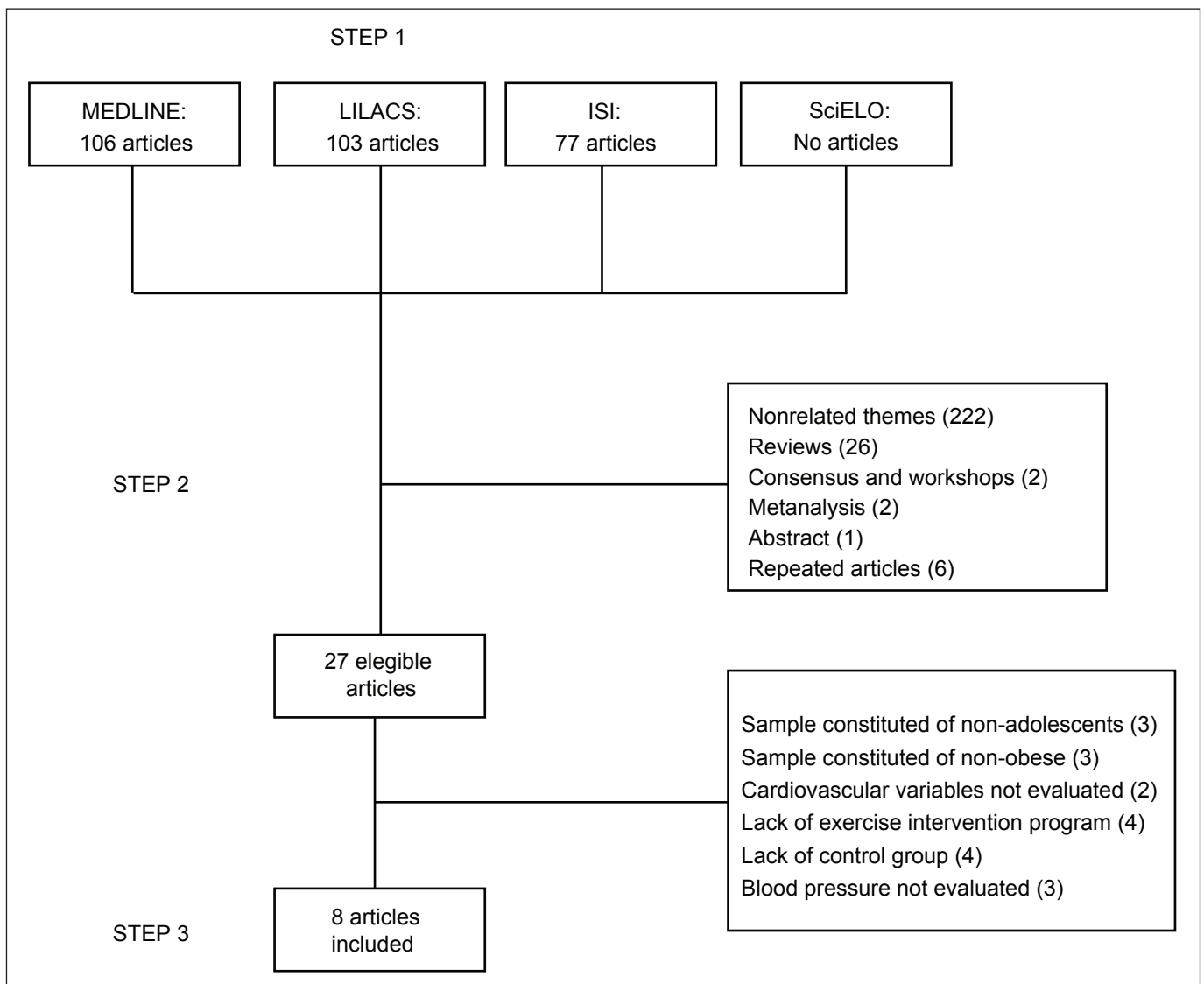


Figure 2 - Flow chart of study selection

Table 1 - General characteristics of the studies included in this review

Author	Year	Groups	n	Age (years)	BMI	PEDro
Rocchini <i>et al</i> ⁽³¹⁾	1987	CH + diet + training	18	10 to 16	NE	6
		Control	15			
			17			
Rocchini <i>et al</i> ⁽³⁰⁾	1988	CH + diet + training	23	10 to 17	NE	6
		CH + diet	22			
		Control	18			
Watts <i>et al</i> ⁽²¹⁾	2004	Training	19	13 to 16	34.4±0.8	6
		Control				
Meyer <i>et al</i> ⁽²⁸⁾	2006	Training	33	11 to 16	29.8±5.9	4
		Control	34		31.0±4.4	
Park <i>et al</i> ⁽¹⁹⁾	2007	Training	19	13 to 15	29.3±2.9	7
		Control	21		29.2±2.4	
Wong <i>et al</i> ⁽²²⁾	2008	Training	12	13 to 14	31.8±4.4	7
		Control	12		30.6±2.1	
Reinehr <i>et al</i> ⁽²⁹⁾	2009	Training	257	10 to 16	NI	6
		Control	186			
Tjona <i>et al</i> ⁽²⁰⁾	2009	Training	28	13 to 14	33.3±4.5	7
		Control	26		33.2±6.2	

CH: Change of habits; BMI: body mass index; NE: not evaluated; NI: not informed; PEDro: score for analysis of the quality of randomized controlled studies⁽³³⁾

Table 2 - Characteristics of the physical training schedules included in this review

Author	Complementary intervention	Duration of the intervention	Training schedule
Rocchini <i>et al</i> ⁽³¹⁾	Dietary	20 weeks	Three weekly sessions of aerobic activities lasting 60 minutes, with intensity 70 – 75% MHR
Rocchini <i>et al</i> ⁽³⁰⁾	Dietary	20 weeks	Three weekly sessions of aerobic and sporting activities and recreational games lasting 60 minutes, with intensity 70 – 75% MHR
Watts <i>et al</i> ⁽²¹⁾	-	8 weeks	Three weekly sessions of aerobic exercises on the cycloergometer plus strength exercises, performed in circuits lasting 60 minutes, with intensity 65 – 85% MHR and 55 – 75% 1MR, respectively
Meyer <i>et al</i> ⁽²⁸⁾	Dietary	24 weeks	Three weekly sessions: Monday – 60 minutes water activities; Wednesday: 90 minutes sporting activities; Friday: 60 minutes walking.
Park <i>et al</i> ⁽¹⁹⁾	Dietary	12 weeks	Six weekly sessions: Monday, Wednesday and Friday – 10 minutes walking in the morning; Tuesday, Thursday and Saturday: 30 – 40 minutes walking in the afternoon, with intensity 55 – 75% MHR
Wong <i>et al</i> ⁽²²⁾	-	12 weeks	Two weekly sessions of aerobic activities and strength exercises, performed in circuit, lasting 55 minutes with intensity of 55 – 65% MHR in the two first weeks, and 65 – 85% in the following weeks
Reinehr <i>et al</i> ⁽²⁹⁾	Psychological	48 weeks	One session a week, with 40 minutes of sporting activities and walking
	Dietary		
Tjona <i>et al</i> ⁽²⁰⁾	Medical	12 weeks	Two weekly sessions of interval aerobic exercises on a treadmill, lasting 40 minutes: 10 minutes of warming at 70% MHR, four sprints lasting four minutes in high intensity (90 – 95% MHR) for each three minutes of active recovery at 70% MHR, and five minutes back to rest.
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CH: Change of Habits; MHR: maximum heart rate; 1MR: one maximum repetition

Table 3 - Main results obtained after physical training in obese adolescents

Author	Groups	SBP (mmHg)		DBP (mmHg)		MBP (mmHg)		Body mass (kg)	
		Initial	Final	Initial	Final	Initial	Final	Initial	Final
Rocchini et al ⁽³¹⁾	CH + diet + training	128±8	114±7*	78±10	69±6*	94±9	84±5*	71±12	68±10*
	CH + diet	125±15	115±7	79±12	69±9	94±13	84±8	72±14	69±14
	Control	126±13	131±16	73±12	77±14	90±10	92±12	73±14	76±15
Rocchini et al ⁽³⁰⁾	CH + diet + training	129±9	113±6*§	79±11	66±7*§	95±10	83±7*	72±12	70±11*
	CH + diet	127±14	117±8	80±11	68±9	95±9	82±8	73±14	70±15
	Control	126±13	130±14	78±10	77±15	90±11	93±12	73±14	77±16
Watts et al ⁽²¹⁾	Training	NI	NI	NI	NI	NI	NI	NI	NI
Control	NI	NI	NI	NI	NI	NI	NI	NI	NI
Meyer et al ⁽²⁸⁾	Training	128±16	120±13*	68.3±5.8	68.3±5.9	NE	NE	NE	NE
	Control	133±14	133±20	68.1±7.3	68.5±7.5	NE	NE	NE	NE
Park et al ⁽¹⁹⁾	Training	118.5±6.0	112.0±7.6*	69.7±5.3	67.5±4.6	NE	NE	75.7±9.4	71.4±9.3*
	Control	119.8±6.9	119.3±7.5	70.4±6.9	69.9±6.5	NE	NE	74.2±6.9	74.5±6.6
Wong et al ⁽²²⁾	Training	119.6±10.8	113.8±7.1	73.8±8.8	71.7±7.5	NE	NE	83.1±8.1	80.7±8.1*
	Control	115.0±8.0	117.0±6.2	71.3±6.8	70.8±6.7	NE	NE	87.6±9.2	88.9±7.4
Reinehr et al ⁽²⁹⁾	Training	127±17	120±15	69±12	64±11	NE	NE	NE	NE
	Control	120±14	122±15	67±12	67±12	NE	NE	NE	NE
Tjona et al ⁽²⁰⁾	Training	128.8±12.8	119.4±7.1	70.4±7.5	64.9±7.1	89.9±8.6	82.7±6.3	94.1±23.3	94.4±6.3
	Control	125.0±12.9	122.5±7.0	65.5±8.6	67.3±7.5	85.3±9.5	85.3±6.5	94.3±15.3	95.4±6.6

CH: Change of habits; *Different from control group ($p<0.05$); §Different from CH + diet group ($p<0.05$); NI: not informed; NE: not evaluated; SBP: systolic blood pressure; DBP – diastolic blood pressure; MBP: mean blood pressure

to physical training. This controversy seems to be directly related to changes in the body mass resulting from physical training. Actually, all the studies that observed a reduction in the systolic blood pressure also showed a reduction in the body mass, and in two of them^(30,31) the changes in both variables were correlated.

The decrease in blood pressure mediated by the reduction of body mass can be explained by mechanical (lesser mechanical compression of the fat mass on the blood vessels), metabolic (reduction of leptin levels⁽³⁷⁾ and insulin resistance⁽³⁸⁾), inflammatory (decrease in pro-inflammatory agents⁽³⁹⁾) and neural (decrease in the sympathetic nerve activity⁽⁴⁰⁾) factors. These results emphasize the importance of the reduction of the body mass in the decrease in blood pressure, which reinforces the importance of the dietary intervention in the treatment of the obese adolescent⁽⁴¹⁻⁴³⁾.

Based on the summary our findings, we identified a great variability in the training protocols used, which may also have contributed to the controversial findings. From the eight studies included, for instance, five used aerobic exercises only, while two used a combination of aerobic training with strength exercises, and only one applied an interval aerobic training. The intensity ranged from 55 to 95% of the maximum heart rate, and the duration of each session ranged from 40 to 90 minutes. It is suggested that the reduction in blood pressure mediated by the physical training results from several factors, such as: improvement in the endothelial function⁽²¹⁾, reduction in the cardiac sympathetic tone⁽⁴⁴⁻⁴⁶⁾, increased sensitivity of the cardiovascular reflexes⁽⁴⁷⁾ and decrease in leptin levels⁽⁴⁸⁻⁵⁰⁾, among others. However, these factors seem less important for the decrease in blood pressure than the reduction of the body mass, since not all the studies that used physical training showed a decrease in blood pressure.

The analysis of the study protocols that found a reduction in blood pressure shows some common points: all of them used at least three sessions of aerobic exercises per week, lasting from 50 to 90 minutes, with intensities from 55 to 75% of the maximum heart rate. Furthermore, no differences in blood pressure were observed in the studies with training duration less than 12 weeks. Therefore, training programs that aim the reduction in the blood pressure of obese adolescents should be based on these training protocols.

Some limitations of the present study should be considered. The literature search was performed in journals indexed in the PubMed/MedLine, LILACS and ISI databases only. It is, thus, possible that some studies on the theme may have not been included. It is noteworthy, however, that the databases used in our study are the most used for searching articles in both Portuguese and English languages. Also, the literature search did not include the databases of theses and dissertations, which could possibly have limited the number of studies included. Finally, the search used only keywords in Portuguese and English only, and studies published in other languages were not included.

The results of this review indicate that there is no consensus in the literature about the cardiovascular effects of physical training on the blood pressure of obese adolescents. Nevertheless, it was possible to identify that studies that showed a decrease in the blood pressure also observed a reduction in the body mass, using protocols of three to six weekly sessions of aerobic exercises lasting from 50 to 90 minutes, with intensities from 55 to 75% of the maximum heart rate, and duration of training ranging from 12 to 24 weeks. In spite of these results, one should take into account that the well planned physical training should be stimulated in this population regardless the blood pressure response in the view of the other positive effects related to training on the reduction of cardiovascular risks.

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