CARDIOVASCULAR EFFECTS OF 16 WEEKS OF MARTIAL ARTS TRAINING IN ADOLESCENTS

EFEITOS CARDIOVASCULARES DE 16 SEMANAS DE TREINAMENTO DE ARTES MARCIAIS EM ADOLESCENTES

EFECTOS CARDIOVASCULARES DE 16 SEMANAS DE ENTRENAMIENTO DE ARTES MARCIALES EN ADOLESCENTES

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ABSTRACT

Introduction: Sedentary habits increase the chances of developing cardiovascular disease. Physical activity is one of the means of prevention and treatment of these diseases, thus martial arts represent a dynamic option in promoting physical activity. Objective: The objective of the study is analyze the effects of 16 weeks of Martial Arts (Muay Thai or judo) training on cardiovascular variables in adolescents. Methods: The sample consisted of 40 adolescents, aged 11 to 14 years, divided into two groups: Martial Arts (n=28) and control (n=12). Weight and height measurements were taken to calculate body mass index. Systolic and diastolic blood pressure (BP), heart rate (HR) at rest, pulse pressure (PP) and rate-pressure product (RPP), were also measured. The intervention was carried out through Martial Arts (Muay Thai and judo) training held twice a week for 90 minutes, over 16 weeks. The control group did not undergo any training. The statistical analysis was performed using the following tests: Shapiro-Wilks, Levene's, analysis of covariance (ANCOVA), eta-squared effect size and the net-effect, using SPSS 15.0 software and a significance level of 5%. Results: There was no statistical difference between the control and Martial Arts groups for the sample characterization. There was a significant difference in systolic BP in the Martial Arts group when compared with the control group (p-value=0.049). The effect size can be considered moderate (effect size=0.163), with a good net-effect (3.4 mmHg). Conclusion: This study showed that 16 weeks of Martial Arts decreased systolic BP in normotensive adolescents. ***Level of Evidence II; Therapeutic studies - Investigating the results of treatment.***

Keywords: Heart rate; Adolescent; Blood pressure; Pulse pressure; Martial arts; Arterial pressure.

RESUMO

Introdução: Os hábitos sedentários aumentam as chances de desenvolvimento de doenças cardiovasculares. A atividade física é um dos meios de prevenção e tratamento dessas doenças, sendo assim, as artes marciais aparecem como uma opção de caráter dinâmico no incentivo à prática de atividades físicas. Objetivos: O objetivo do estudo consiste em analisar os efeitos de 16 semanas de treinamento de artes marciais (Muay Thai ou Judô) sobre as variáveis cardiovasculares nos adolescentes. Métodos: A amostra foi constituída por 40 adolescentes de 11 a 14 anos, divididos em dois grupos: artes marciais (n=28) e controle (n=12). As medições de peso e altura foram realizadas para o cálculo do índice de massa corporal. Foram medidas também a pressão arterial sistólica e diastólica (PA), a frequência cardíaca (FC) em repouso, a pressão de pulso (PP) e o duplo produto (DP). A intervenção foi realizada através da prática de artes marciais (Muay Thai e Judô), realizada duas vezes por semana, durante 90 minutos, por 16 semanas. O grupo controle não realizou nenhum tipo de treinamento. A análise estatística foi feita utilizando os seguintes testes: Shapiro-Wilks, Levene, análise de covariância (ANCOVA), tamanho do efeito eta-squared e efeito líquido, utilizando o software SPSS 15.0 e nível de significância de 5%. Resultados: Não houve diferença estatística entre o grupo controle e o grupo de artes marciais para a caracterização da amostra. Houve diferença significativa na PA sistólica no grupo de artes marciais quando comparado com o grupo controle (valor p=0,049). A dimensão do efeito pode ser considerada moderada (dimensão do efeito=0,163), com um bom efeito líquido (3,4 mmHg). Conclusão: Este estudo demonstrou que 16 semanas de artes marciais diminuíram a PA sistólica em adolescentes normotensos. ***Nível de Evidência II; Estudos terapêuticos - Investigação dos resultados do tratamento.***

Descritores: *Frequência cardíaca; Adolescente; Pressão sanguínea; Pressão de pulso; Artes marciais; Pressão arterial.*

RESUMEN

Introducción: Los hábitos sedentarios aumentan las posibilidades de desarrollo de enfermedades cardiovasculares. La actividad física es uno de los medios de prevención y tratamiento de esas enfermedades, siendo así, las artes marciales aparecen como una opción de carácter dinámico en el incentivo a la práctica de actividades físicas. Objetivos: El objetivo del estudio es analizar los efectos de 16 semanas de entrenamiento de artes marciales (Muay Thai o Judo) sobre las variables cardiovasculares en adolescentes. Métodos: La muestra fue constituida de 40 adolescentes de 11 a 14 años, divididos en dos grupos: artes marciales (n=28) y control (n=12). Fueron realizadas mediciones de peso y altura para calcular el índice de masa corporal. Fueron medidas también la presión arterial sistólica y diastólica (PA),

frecuencia cardíaca (FC) en reposo, la presión de pulso (PP) y el doble producto (DB). La intervención fue realizada a través de la práctica de artes marciales (Judo y Muay Thai), realizada dos veces por semana durante 90 minutos, por 16 semanas. El grupo control no realizó ningún tipo de entrenamiento. El análisis estadístico fue hecho usando los siguientes tests; Shapiro-Wilk, Levene, análisis de covarianza (ANCOVA), tamaño de efecto eta-squared y efecto neto, usando el software SPSS 15.0 y el nivel de significación de 5%. Resultados: No hubo diferencia estadística significativa entre el grupo control y el grupo de artes marciales para la caracterización de la muestra. Hubo diferencia significativa en la PA sistólica en el grupo de artes marciales, cuando comparado con el grupo control (valor p=0,049). La dimensión del efecto puede ser considerada moderada (dimensión del efecto=0,163) con un buen efecto neto (3,4 mmHg). Conclusión: Este estudio demostró que 16 semanas de artes marciales disminuyeron la PA sistólica en adolescentes normotensos. ***Nivel de Evidencia II; Estudios terapéuticos - Investigación de los resultados del tratamiento.***

Descriptores: *Frecuencia cardíaca; Adolescente; Presión sanguínea; La presión del pulso; Artes marciales; Presión arterial.*

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INTRODUCTION

Cardiovascular diseases are the leading causes of deaths worldwide.[1] Blood pressure is an independent, linear and continuous risk factor for cardiovascular disease.[2,3] Alterations in blood pressure is a major risk factor for the development of hypertension in the young population,[4] and given that high blood pressure during adolescence tracks into adulthood,[5] early therapeutic approaches should be employed in young people.

Martial arts are a popular form of exercise for children and adolescents.[6] Studies have demonstrated the benefits of Martial Arts for improving physical fitness,[7,8] performance[9-11] and bone health.[12] However, whether Martial Arts can alter the cardiovascular profile is unknown. Given that high intensity exercise potentiates the cardiovascular effects of exercise in young people,[13] and that martial arts usually have moderate to high intensities,[14,15] it is possible that this mode of exercise could affect cardiovascular function in this age-group.

Thus, the aim of the present study was to analyze the effects of 16-weeks of martial arts training (Muay-Thai or judo) on cardiovascular variables in adolescents. We hypothesized that martial arts training would improve cardiovascular health in adolescents.

MATERIALS AND METHODS

This study was developed in a social project in Presidente Prudente-Brazil (Southeastern Brazil), carried out with low income adolescents. This project provides various activities for young people (chess, computer activities and practicing different sports, among others). Adolescents were included if they: (i) were enrolled and participating in the activities of the above mentioned institution; (ii) did not present any serious orthopedic disease that prevented them from performing Martial Arts; (iii) were not taking medication to control blood pressure; (iv) did not have any respiratory illness that prevented them practicing exercise. All participants returned the Informed Consent form signed by parents or guardians giving permission for participation and the study was approved by the Research Ethics Committee of the Universidade Estadual Paulista (Process number: 26702414.0.0000.5402).

Body mass was measured using an electronic scale, Filizola, accurate to 0.1 kg, with a maximum capacity of 150 kg and height using a fixed stadiometer, Sanny, with a precision of 0.1 cm and maximum extension of two meters.

Systolic and diastolic blood pressure (BP) were obtained using an automatic blood pressure monitor (brand Omron Healthcare, Inc., IntelliSense, model HEM 742, Omron Corporation, Model HEM 742, Kyoto, Kansai, Japan) with cuffs of appropriate size to the arm circumference of the participants,[16] obtained on the right side with the arm at a height in line with the heart. The participant remained seated and after resting for approximately 15 minutes the blood pressure was measured.[17] All BP measurements were performed three times in the right arm and the mean of the final two measures was used for analysis. This blood pressure device has been previously validated for use in adolescents.[18] Pulse pressure (PP) was defined as the difference between the systolic and diastolic BP readings.

Heart rate (HR) was obtained with a heart rate monitor (Polar FT-1 model T-31 Owncod-coded transmitter, Finland) with the cardiofrequencimeter fixed at the sternum, specifically at the xiphoid process. For the evaluation of resting heart rate the adolescents remained resting for 15 minutes until the assessment was performed. The rate pressure product (RPP) was calculated as the product of HR and systolic BP.

The social project offered leisure activities such as: Judo, Muay-Thai, chess, computer and music to adolescents. The adolescents were divided into two groups: Martial Arts (Judo and Muay-Thai) and Control (chess, computer and music). The Martial Arts group performed 16 weeks of training, after a two week adaptation period. The training was conducted twice a week; each session had a duration of 90 minutes, as recommended by the American College of Sports Medicine Guidelines.[19] Each session consisted of 15 minutes of stretching, 10 minutes of warming up, 60 minutes of specific martial arts training (as detailed below) and five minutes of cooling down with stretching. Both training programs were of moderate intensity, monitored by the perceived exertion scale.[20] All the participants were previously familiarized with the use of the RPE scale.

The control group performed other activities twice a week during the 16 weeks. They were instructed to maintain their usual physical activity levels throughout the study.

The judo training was based on the principles of the sport and was characterized as a fight for domain, aiming to grab and hold an opponent. Initially, we developed a series of pre-sport activities. These included games involving the field of the opponent's footprint, conquests for territory using the elements of judo ground fighting, crouching fights, with the goal of unbalancing the opponent, and catching adapted to the sport, practiced in fours and composed of guards and bearings. In addition, specific activities for the improvement of judo techniques were performed. First falls (forward, sideways and backward) and bearings (for right and left) were learnt, followed by incoming blows, which training specific to learning and the correct execution of the blows. In addition, ground game was practiced, which is a struggle carried out on the ground, where the practitioners enhance their immobilization and strangulation techniques. Finally the fight itself was performed, where the individuals used all the above techniques in a single activity.

Muay-Thai training is characterized as a percussion fight, with the aim of striking the opponent to score points. Initially, the training included less complex activities and low intensity for the participants who were familiar with the sport, such as balance activities, striking parts of the

body, strength, agility, coordination and development of laterality. This progressed to more specific activities, such as kicking, kneeing, punching, elbowing, dodges and defenses, always using equipment and adequate safeguards aimed at the safety of the students.

After learning these specific activities, the process of unification of blows began, with sequences that always used arms and legs to impede movement, in addition to a gradual increase in intensity. After learning the movements and techniques, the students began performing combat simulations with the teachers.

Statistical analysis

Normality and homogeneity of variance were verified using the Shapiro–Wilks and Levene's tests, respectively. Sample characterization variables were presented as mean and standard deviation. To compare the cardiovascular effects of the interventions, adjusting for age and sex, analysis of covariance (ANCOVA) was used. The eta-squared effect size and net-effect (Δ Martial Arts group - Δ Control Group) were obtained. The statistical significance was 5%. The statistical package used in the analyzes was SPSS 15.0

RESULTS

Seventy adolescents aged 11 to14 years were initially enrolled in the present study. During the intervention period 30 adolescents left the study for exceeding the number of absences or not performing the evaluations (sample loss of 42.8%). Thus, the final sample consisted of 40 adolescents (28 boys), divided into Martial Arts (n=28) and Control (n=12). (Figure 1)

At baseline, there were no significant differences between the intervention groups regarding anthropometric variables, systolic BP (p-value=0.259), diastolic BP (p-value=0.437), resting HR (p-value=0.277), PP (p-value=0.266) or RPP (p-value=0.208). The sample characteristics are shown in Table 1.

Figure 2 and Figure 3 presents the cardiovascular effects of the interventions. There were significant decreases in systolic BP in the Martial Arts group (p-value<0.05), while the control group presented increases (p-value<0.05). The changes in the Martial Arts group was significantly greater than the control group (p-value=0.049). The effect size for the Eta-squared can be considered as large (effect size= 0.163). There were no significant changes in diastolic BP, resting HR, PP or RPP in either the Martial Arts or control group (p-value>0.05) with a low effect size in both.

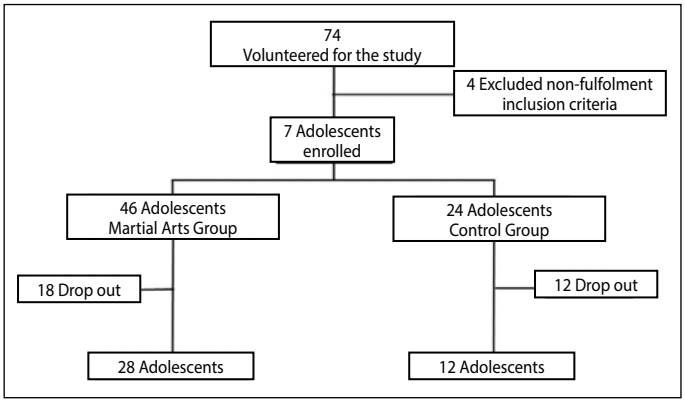

Figure 1. Flow diagram of the sample.

Table 1. Characteristics of the sample according to the group at baseline.

Variables	Martial arts (n=28)	Control (n=12)	*p*-value
Sex (%boys)	71.5	66.7	0.785
Age (years)	10.9 (1.4)	11.0 (1.4)	0.110
Weight (kg)	41.3 (13.1)	48.2 (14.3)	0.135
Height (cm)	146.9 (10.7)	151.8 (11.1)	0.197
Body mass index (kg/m^2)	18.8 (4.1)	20.5 (4.1)	0.233
Systolic BP (mmHg)	106.0 (7.3)	112.1 (16.4)	0.259
Diastolic BP (mmHg)	59.6 (9.4)	62.1 (8.0)	0.437
Pulse pressure (mmHg)	45.96 (8.9)	50.00 (12.6)	0.266
Heart rate (bpm)	76.8 (11.3)	81.2 (12.8)	0.277
Rate pressure product (bpm*mmHg)	8171.2 (1275.7)	9019.8 (848.1)	0.208

BP= Blood pressure, values are presented as mean (Standard deviation) or frequency.

DISCUSSION

The results of this study indicated that 16 weeks of Martial Arts training performed twice a week decreased systolic BP in adolescents. These results suggest that Martial Arts, including Judo and Muay-Thai, can be used to lower BP in young people.

This is the first study to show a reduction in systolic BP following Martial Arts training in adolescents. The strengths of the study include controlling for various potential confounders, the homogeneity of the sample and this being the first study to analyze the effects of martial arts on cardiovascular variables in adolescents. In fact, previous studies[21,22] that analyzed the effects of Martial Arts on cardiovascular variables were performed in cohorts of either healthy adults or elderly individuals or those with cardiometabolic diseases. In addition, only Tai Chi Chuan has been investigated.[23] thus, the effects of other Martial Arts, such as Judo and Muay Thai, which are confrontation Martial Arts and the most intense, are unknown.

The present study demonstrated an improvement in systolic BP after 16 weeks of Martial Arts, with a net-effect of 3.4 mmHg. These findings demonstrated that Martial Arts, such as Judo and Muay-Thai, are an interesting form of prevention for cardiovascular disease in adolescence, which is interesting given that high blood pressure during adolescence tracks into adulthood[5]. In addition, it is know that a reduction of 2 mmHg in systolic BP results in a 6% decrease in the risk of stroke and a 4% reduction in the risk of cardiac heart disease.[24]

Similar findings have been observed in other studies with Martial Arts in adults and the elderly. For example, Lo et al.[25] found a significant reduction in both systolic and diastolic BP in hypertensive adults after 8 weeks of Tai Chi Chuan training (3 times a week, 60 mins per session). Zheng et al.,[26] in their meta-analytical study with 22 studies, found that Thai Chi Chuan training reduced systolic BP in healthy adults. Similarly, Squarcini et al.[21] analyzed the benefits of karate practice (3 times a week, 60 minutes, for 3 months) in healthy hypertensive elderly individuals and found that, in addition to other benefits in quality of life, these women significantly decreased systolic blood pressure.

Although it was not been aim of this study to analyze the underlying mechanisms, it can be speculated that there was maintenance or a small increase in cardiac output in the Martial Arts group, whereas in the control group there was an increase in cardiac output, especially through the increase in HR. Comparison with other studies involving adolescents and Martial Arts is limited by the lack of studies. However, a recent meta-analysis observed a small increase in cardiac output (small reduction in heart rate and small increase in stroke volume) after Tai Chi Chuan training in healthy adults. Future studies should be performed to investigate these variables in adolescents.

The non-randomization is the main limitation of this study, which explains in part why the groups were not matched, in addition to the absence of physiological variables to explain the decreases in blood pressure. In addition the analysis considering the martial arts group with judo and muay-thai practitioners in the same group can be considered as a limitation, since these martial arts have their specificities. However, these groups did not differ among themselves and were treated together in comparison with the control group to increase the power of statistical analysis. Finally, this study included only normotensive adolescents; therefore, our data need to be interpreted cautiously and may not be generalizable to

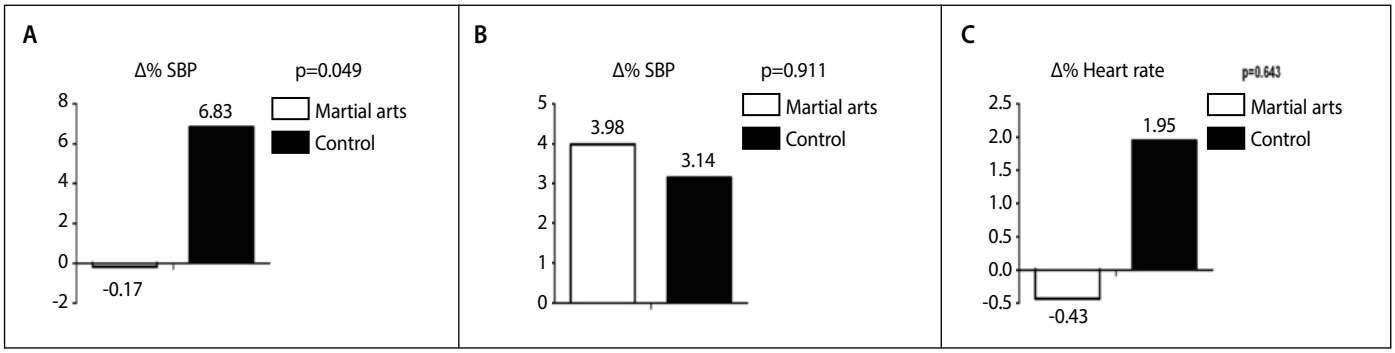

Figure 2. Comparasion of Δ% of systolic blood pressure (SBP), diastolic blood pressure (DBP) and heart rate in martial arts and control group. *Adjusted by sex and body mass index (BMI).

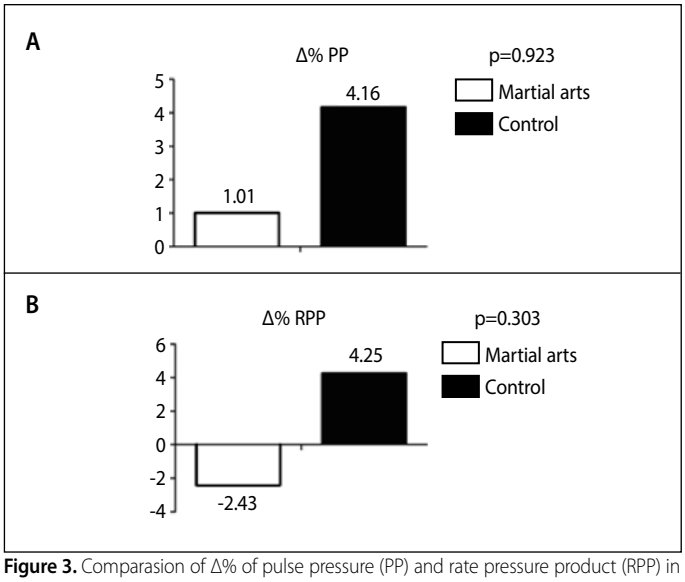

Figure 3. Comparasion of Δ% of pulse pressure (PP) and rate pressure product (RPP) in martial arts and control group. *Adjusted by sex and body mass index (BMI).

all adolescents; it is possible that the results could have been better in hypertensive adolescents.[27] Finally, although the participants' ages were tightly controlled, we did not determine the Tanner stage.

CONCLUSION

In summary, this study showed that 16 weeks of Martial Arts decreased systolic BP in normotensive adolescents. Therefore, Martial Arts could be an alternative mode of physical activity to improve cardiovascular health and prevent cardiovascular diseases in young people.

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