Ten weeks of capoeira progressive training improved cardiovascular parameters in male practitioners

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Title: TEN WEEKS OF CAPOEIRA PROGRESSIVE TRAINING IMPROVED CARDIOVASCULAR PARAMETERS IN MALE PRACTITIONERS

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3): Tables 5
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4): Tables 6
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RESPONSES TO THE REVIEWERS (Manuscript: *J Sports Med Phys Fitness*-6030)

Dear referee, thanks for reviewing our manuscript. Your comments really contributed to make it better. So please, find below our responses to each comment pointed out.

**Responses to the “Reviewer #1”**. The manuscript was adjusted as a result of referee’s comments. All changes in the manuscript are addressed below and underlined on the document.

**Comment #1** Thank you to the authors for the submission of a scientific article in an area of recreational physical activity that is not currently well represented in the literature. However, there is little supporting information in the introduction that compels the completion of such a trial. Is it not fully understood that chronic participation in any chronic physical activity will induced cardiovascular changes in comparison to no participation? More information needs to be included as to why it is important to show that capoeira practitioners lowers heart rate or improves HRV.

**Response** Thanks for the comment. We agree with the reviewer. In fact and in accordance to the reviewer #2 too, the introduction was not well structured and with little supporting information. It was also pointed out that the scientific rationale for conducting the study was lacking. As a result, the introduction was rewritten in order to better support the rationale for the study, particularly as regarding to Capoeira and the possible effects one may have on the cardiovascular system as a result of Capoeira training. Below there is a point included in the third paragraph of the introduction:

“The Capoeira can be performed at different paces, marked by Angola and Benguela styles, as well as by São Bento style. The first two are more likely to rely on aerobic energy pathways, while the São Bento style may have either aerobic or anaerobic predominance depending if the practitioners are beginners or advanced, respectively. These styles differ in the specificity of the technique and speed of execution of movements.”

**Comment #2** Prior to any follow up submissions the manuscript needs to be carefully proof read by an individual fluent in English. Currently there are many word misuses that detract from any scientific merit. The introduction and the discussion both need to be improved.

**Response** Now the manuscript was revised by a senior researcher of our research team, who lives in USA. However, we are still open to any additional suggestions, and ready for further corrections that would be necessary to achieve the standard of quality of this reputable journal. Thank you for comments.

**Comment #3** The methodology could be improved by adhering to ACSM standards for exercise prescription. Specifically, utilize the FITT framework and report the frequency, intensity, time, and type of training for each week to demonstrate the physiological impulse for cardiovascular change. The term periodization is incorrectly utilized. This term refers to
Response) Thanks for the comments. As a result, the methodology (Text and Table II) was reformulated in accordance to FITT (frequency, intensity, time and type of training). Moreover, the number of repetitions and recovery time between sets are presented in Table II. The “periodization” term was deleted and/or replaced by “progressive training program” sentence in all manuscript. Thank you for your suggestions.

Comment #4) Page 9, line 19 - The description of the "Basic Programmed Lesson program" is extremely confusing. Please simplify and clarify the progression of the exercises.

Response) The topic was simplified as requested, and now has a clearer description of the progression of sequences of exercises during the program (please see below), which corroborates the information contained in Table II. Thanks for the comment.

“In order to perform the Basic Programmed Lesson during the Capoeira progressive training program, the activities were divided in four stages (Table I). These stages were composed by main movement that characterizes the Capoeira (the “ginga”) and by other movements such as dodging, unbalancing, impact, and acrobatic movements (Figure 2). The model of Capoeira progressive training program is described in Table II. Usually, each sequence of movements during the program was repeated by 30 to 10 times, with 60 to 180 seconds apart, respectively. The technical improvement naturally occurred every week, resulting in a higher speed in movements execution and thus to a gradual increase in training intensity. However, the number of repetitions in each sequence was progressively decreased in parallel to the increase in training intensity.

Comment #5) Page 10, line 13 - Please double check the rating of perceived exertion scale utilized in previous research. The validated Borg scale indeed contains 15 points, but ranges from 6-20. The current wording of this sentence does not make that clear.

Response) Thank you. Now the sentence was rewritten properly. The variation of the scale used previously was clarified as follows: “Furthermore, the average rating of perceived exertion (RPE) during the session was 12±2 on the 15-point Borg’s scale that ranges from 6 to 20.”.

Comment #6) Page 12, line 62 - There is a lot of discussion about non-significant results. It is difficult to extrapolate that these changes did not happen by chance if they were not significant. This space would be more appropriate to explain some of the main effects of time that were significant but showed no interaction (i.e., blood pressure).

Response) We agree with the comment of the reviewer. Thus, the discussion of non-significant results was minimized. In addition, a brief discussion of the effect of time was included (as follows below), followed by possible clinical applications of the results. Thanks for the comment.

“The present study found non-significant interaction of time by group in SBP, DBP, MAP, and in the RPP. On the other hand, the main effect of time for these variables in the Capoeira group was evidenced (p<0.05). Clinical implications …”.
Comment #7) Table 1- This table does not help a person unfamiliar with capoeira.

Response) We sincerely apologize for Table 1. The purpose of this table is to describe the movements of Basic Programming Lesson of Capoeira divided by stages, according to the application during the Capoeira progressive training program (Table II), which describes the programming for the application of different stages. In fact it was not easy to describe all movements of Capoeira, a sport still unusual in the scientific literature. So its description for the Basic Programmed Lesson protocol chosen for the present study was also difficult for us. However, we decided to include Figure 2 with the visual display of the movements what, in turn, may be helpful for the understanding of the content listed in Table I. Thank you for your observation.

Comment #8) Table 2 - This table should seek to quantify the training impulse rather than list the durations. The term "workload" is incorrectly used. Time is not work, nor are repetitions.

Response) Thanks for the comments. Now the table II is modified and brings information regarding the frequency, intensity, time and type of training. The term "workload" was deleted.

Comment #9) Table 3 - Please hypothesize as why blood pressure dropped in both groups? The mean blood pressures starting this training study are pre-hypertensive. Please comment on how this might effect the findings? Does this make the experiment more or less relevent.

Response) Thanks for the comment. It was possible to highlight the main effect of time (as suggested in Comment # 6), where only the Capoeira group demonstrated significant decrease in BP after training (Bonferroni-corrected multiple pairwise comparisons). From this, a greater importance was attributed to the result obtained, and it was possible to discuss a possible mechanism of BP decrease over time. The following point was included in the third paragraph of the discussion:

"So, the main effect of time on BP becomes even more relevant, especially due to the resting BP of the sample that indicated a pre-hypertension classification before intervention. Neural mechanisms may be related to the drop in BP from chronic adaptations including an increased parasympathetic tone and or reduced sympathetic nerve activity on resting." 

Finally, we thank your attention and contribution in reviewing our manuscript. The acceptance of the present manuscript in a well-recognized journal like the Journal of Sports Medicine and Physical Fitness would also strengthen the relevance of the work we have been doing in this area in Brazil. This would help us to get support of federal agencies that encourage the development of research in our country and thus allow us to continue our studies and to produce important knowledge both for the scientific community, coaches and practitioners of Capoeira.

Sincerely,
The authors
Responses to the “Reviewer #2” and location of the main changes in the text

The requested corrections and suggestions were assisted and are presented below. All changes in sentences of the manuscript are bold over the text.

Comment #1) The study evaluates the effects of ten weeks of periodized Capoeira training on the cardiovascular parameters of male practitioners. The authors have found that ten weeks of periodized Capoeira training improved both autonomic and cardiovascular parameters in male practitioners. The study adds novel but not significant data to the existing knowledge.

Response) Thank you for the comment. We agree that some data (i.e. related to training adaptations per se) are not new. However, when we consider that the object of study was the Capoeira, we do believe that this study has novelty. In addition, this was also pointed out by the reviewer #1, whose comments indicated that the study presents information in an area of recreational physical activity that is not currently well represented in the literature. So we hope to contribute with initial scientific information regarding physiological benefits of Capoeira. For the final reader it is important to know that Capoeira basic Training may bring benefits to cardiovascular system, not only by performing traditional exercise modes or sport-related practices. Thank you for your comment.

Comment #2) The abstract reflects the content of the article. Page 2: Please, specify “basic training program”. “The Capoeira group performed ten weeks of basic training program, being one session per week lasting 90 minutes each.”

Response) Thank you for your comment. The “basic training program” term was replaced by “Capoeira progressive training program”, what best represents the applied training model, as shown in a new Table II of present study. More detailed information about the applied training program are now shown in Materials and Methods. Unfortunately some information were not included in abstract because the space for its construction is limited between 200 and 250 words in accordance to instructions to authors.

Comment #3) The introduction is not well structured. The scientific rationale for conducting the study is lacking. The authors only report that there is limited information in this field of research. Page 5: “To date there are no studies investigating the chronic cardiovascular adaptations in practitioners as a result of participation in an exercise training program composed exclusively by basic Capoeira techniques. The information about the impact of Capoeira on cardiovascular variables may contribute to the body of scientific literature, and exercise prescription aiming to the improvement of the cardiovascular function and aerobic fitness.”.

Response) Thanks for the comment. In fact the introduction was not well structured. Thus, part of the introduction was rewritten in order to better support the rationale for the study, particularly as the requirement of Capoeira and its possible adaptation in the cardiovascular system. To note, below there is a point included in the third paragraph of the introduction:

“The Capoeira can be performed at different paces, marked by Angola and Benguela styles, as well as by São Bento style. The first two are more likely to rely on aerobic energy pathways, while the São Bento style may have either aerobic or anaerobic predominance depending if the practitioners are beginners or advanced, respectively.”
These styles differ in the specificity of the technique and speed of execution of movements. The physical demand for the practitioners reflects an important and gradual aerobic work, which over time may result, at least for the healthy beginners, in cardiovascular adaptations.

Comment #4) The authors need to clearly set up the hypothesis. Page 5: "... the present study aimed at analyzing the effects of ten weeks of Capoeira training on the cardiovascular parameters in male practitioners. A secondary purpose was to present for the first time a suggestion of Capoeira Training with periodization model focusing the cardiovascular benefits for the practitioners."

Response) We agree with the reviewer. Now the hypothesis of this study is highlighted in the end of the introduction, as follows:

“This way, the hypothesis of this study was that ten weeks of Capoeira progressive training program would decrease resting heart rate and BP and increase HRV in male practitioners.”

Comment #5) Experimental design is appropriate. However, the question remains whether the training program consisting of “one session per week lasting 90 minutes each“ was adequately designed. Page 8: “The experimental protocol for Capoeira training lasted ten weeks and was performed once a week with duration of 90 minutes each. Each session was divided in three parts, being: 1) initial part: consisting of a 15 minutes warm-up with recreational activities at low intensity and/or the “ginga” used in Capoeira; 2) main part: following the directions from the Basic Programmed Lesson (~55 minutes) and; 3) final part: with a Capoeira presentation of approximately 20 minutes. During this last period, the participants remained in a circle and, in pairs, freely executed the movements practiced earlier in the sessions.”

Response) We agree with the reviewer. In fact, several traditional exercise recommendations suggest at least a frequency of 2 times a week to conduct a training program. However, it has also been suggested that a larger volume even performed only once a week can result in positive physiological adaptations, especially for untrained individuals or even not adapted to the type of exercise used in the program, as was the case for the participants of the present study.

This assumption may be supported by some current studies in which a low frequency of training was performed.

In a study from Nakaraha et al. (2015) for example, was conducted a cycle ergometer interval training program once per week for 12 weeks. The intensity was 80% maximum work rate. The authors found significant physiological effects such as an increase of 13% in \( \text{VO}_{2\text{MAX}} \), 21% in ventilatory threshold and 18% in left ventricular posterior wall thickness. Moreover, these authors also demonstrated a 12% reduction in minute ventilation and 16% in blood lactate concentration for a high-intensity exercise after the training program in comparison to baseline.

Another study (KIML et al., 2015), while investigating the association between physical activity and metabolic syndrome, found that the odds ratios (95% CI) for having metabolic
syndrome and engaging in vigorous physical activity, moderate physical activity or light physical activity (walking) compared with having metabolic syndrome and not engaging in physical activity (vigorous, moderate or light walking) were 0.482 (0.322-0.721, p<0.001), 0.547 (0.370-0.810, p=0.003) and 0.482 (0.318-0.731, p<0.001) for physical activity once a week.


Still, when it comes to Capoeira training, there is a lack in literature of the effects of Capoeira either regarding the frequency, intensity and duration of the program. So that we expected to give our contribution regarding the benefits of Capoeira per se, besides showing that even exercising once a week would enable for cardiovascular benefits. In this sense, it was decided to conduct the study’s training protocol with a physiological impulse to once a week for 10 weeks, however, with the volume of 90 minutes each session, which we believe would be the minimum enough for the occurrence of cardiovascular adaptations. Further studies are needed testing different frequencies and volumes of Capoeira training in cardiovascular adaptations for different populations. Thank you for your comment.

Comment #6) In addition, more information on intensity of exercises in each part of the training session as well as its increase during the period of ten weeks is needed. Pages 9 – 10: „ In results by our laboratory (unpublished data) with a sample of 16 practitioners (10 male and 06 female), it observed that the average intensity of a session with Capoeira basic training was 65±7% of maximum heart rate previously measured by an incremental aerobic exercise test. Furthermore, the average rate perceived exertion during the session was 12.2±1.1 points in the Borg’s scale of 15 points.”.

Response) Now it was possible to include additional information about the intensity of exercise in different parts of Capoeira training session, as follows:

“…During the training session the exercise intensity changed from the initial part (58±7% HRmax and RPE of 10±2) to the main part (73±7% HRmax and RPE of 14±2) and final part (72±10% of HRmax and RPE of 14±2).”.

In addition, from the second column of the Table II of the present study it is demonstrated the progression of the intensity, which ranged from low to moderate throughout the ten weeks of training. Thanks for the comment.

Comment #7) The experimental group is small but acceptable. The authors should explain how they control the physical activities of participants included in the experimental and control group.

Page 5: “The allocation of the participants was based on the university’s enrollment records for participation in the basic course of Capoeira and other courses that did not require performing any physical activity over time.”
Page 6: “All participants had at least a 24 month period without practicing Capoeira and were oriented to not participate in any other physical activity programs throughout the present study.”

Page 2: “The Control group was instructed to avoid any exercise training program or intense physical activities during the experimental period.”

Similarly, the authors should clarify how the dietary routines of participants during ten weeks of intervention were controlled.

Page 8: “The participants of both groups were instructed to maintain their dietary routines during the ten weeks of intervention, as well as during the day of cardiovascular evaluation.”

Response) Thank you for the comment. We did an effort to better describe and point out this issue as one of the limitations of the study. Please see discussion section in the penultimate paragraph, as follows:

“There was no control of dietary intake and physical activities of participants included in the experimental and control group. However, it was assumed that both groups (Capoeira and Control) followed the recommendation that was to maintain their dietary routines and physical activities during the ten weeks of experiment.”

Comment #8) The parameters analyzed are clearly described. Results: Findings are clearly presented.

Response) Thank you for your comment.

Comment #9) The discussion reflects what authors found. Please, remove “Tables and Figures” from the discussion. However, the authors should incorporate previous research into their interpretation of the results. Moreover, the discussion needs to present the practical applications that are not currently addressed in the literature. In particular, the authors need to clear out the practical application of the obtained findings with respect to a specific group of population.

Response) The “Tables and Figures” were removed from the discussion as requested. In the third paragraph (penultimate sentence) and fourth paragraph (fourth and fifth sentence) of the discussion it was possible to incorporate previous studies (reference number 18 and 34) indicating possible mechanisms that would be associated to the adaptations observed for the participants of the present study. The last paragraph of the discussion (practical applications) was improved to meet the reviewer’s recommendations. Thank you for your comment.

Comment #10) Conclusions: The weak point of this paper is a limited novelty when taking into account several papers documenting improvement of cardiovascular functions following various training programs.

Page 15: “… ten weeks of Capoeira training according to the Basic Programmed Lesson method, by using the periodization model with a once a week 90-minutes session improved markers of cardiovascular function such as reduced HR responses, and increased HRV indicators in male practitioners.”
Response) We partially agree with the reviewer’s comment. We agree that there are several papers documenting improvement of cardiovascular functions following various training programs. However, there are very few papers regarding Capoeira, and none investigated most of the variables covered in our experimental design. The present study presents information regarding cardiovascular adaptations in an area of recreational physical activity that is poorly investigated (Capoeira). So, we hope to contribute with some specific information regarding the physiological effects of this modality that is so traditional in Brazil, but also a martial art/dance that has been practiced in more than 150 countries. Thanks for the comment.

Finally, we thank your attention and contribution in reviewing our manuscript. The acceptance of the present manuscript in a well-recognized journal like the The Journal of Sports Medicine and Physical Fitness would also strengthen the relevance of the work we have been doing in this area in Brazil. This would help us to get support of federal agencies that encourage the development of research in our country and thus allow us to continue our studies and to produce important knowledge both for the scientific community, coaches and practitioners of Capoeira.

Sincerely,
The authors
Ten weeks of *Capoeira* progressive training improved cardiovascular parameters in male practitioners

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ABSTRACT

BACKGROUND: The present study analyzed the effects of ten weeks of Capoeira progressive training program on the cardiovascular parameters of male practitioners.

METHODS: Participants were assigned into two groups [Capoeira, n=10; 25.4±3.3 years; 24.2±2.2 kg.m\(^{-2}\)] and Control, n=8; 29.6±6.3 years; 26.4±4.4 kg.m\(^{-2}\)]. The Capoeira group performed ten weeks of Capoeira progressive training program, being one session per week lasting 90min each. The Control group was instructed to avoid any exercise training program or intense physical activities during the experimental period. The blood pressure (BP), heart rate (HR), and rate pressure product (RPP), as well as HR variability (HRV) indicators were evaluated on resting, before and after intervention.

RESULTS: A two-way ANOVA revealed a main effect of group by time interaction to HR (F=6.649, \(\eta^2=0.379; p=0.02\)), and HRV indicators (RRi: F=5.752, \(\eta^2=0.313\); rMSSD: F=4.652, \(\eta^2=0.283\); SD1: F=4.694, \(\eta^2=0.409\), and pNN50: F=5.561, \(\eta^2=0.360\); p<0.05). A main effect of time condition was verified for Capoeira group (p<0.05) on HR (\(\Delta=-6.6\pm6.0\) bpm), RRi (\(\Delta=8.0\pm6.4\) ms), rMSSD (\(\Delta=14.1\pm11.6\) ms), SD1 (\(\Delta=10.0\pm8.2\) ms), and pNN50 (\(\Delta=11.3\pm9.7\)%). The between groups analysis identified significant differences (p<0.05) for the HR after intervention (Capoeira: -8.6±6.9% vs. Control: -0.7±3.9%). The comparison between Capoeira vs. Control for HRV indicators (RRi: \(\Delta=10.1\pm8.5\) vs. 0.9±7.6%; rMSSD: \(\Delta=37.8\pm32.9\) vs. 2.9±31.3%; pNN50: \(\Delta=96.2\pm78.7\) vs. 0.3±54.1%; and SD1: \(\Delta=37.7\pm32.9\) vs. 6.5±24.4%; respectively) differed to each other (p<0.05).

CONCLUSION: Our findings showed that ten weeks of Capoeira progressive training program improves both autonomic and cardiovascular parameters in male practitioners.

Key words: Brazilian fight – Chronic effects – Blood pressure – Heart rate variability.
INTRODUCTION: Lifestyle changes have been recommended for the prevention and treatment of comorbidities associated with cardiovascular risk factors. The inclusion of aerobic and dynamic resistance exercise training has been currently highlighted as an important strategy for prevention, treatment and control of high blood pressure (BP). Among the physiological variables associated with BP control, the indicators of autonomic nervous system activity, such as markers of the heart rate variability (HRV), have been shown to be useful for clinical purposes. A higher HRV was shown to be associated with lower mortality rates and has been suggested as an important tool on the prevention and early detection of potential cardiovascular diseases.

HRV has also been extensively used as a marker of autonomic adaptation to different exercise modes such as resistance training, aerobic training, judo and tai chi chuan. However, there is still a lack in literature regarding the effects of alternative forms of physical training, other than the aforementioned traditional ones. It is well-known that every exercise session elicits BP to increase acutely, what in turn may lead to chronic adaptations in cardiovascular system including an increased parasympathetic tone on resting and submaximal exercises what, in turn, may be of special importance to prevent hypertension.

Among the sports eliciting acute cardiovascular adaptations, we can highlight Capoeira as a Brazilian martial art/dance that has spread worldwide. Such modality is defined as an athletic sport characterized by attack and defense systems, originally created in colonial Brazil. Currently, the Capoeira is present in more than 150 countries and its practice has been carried out by different social groups over the five continents. Capoeira is characterized by its main movement, called “ginga”, and by several others such as dodge, unbalance, impact and acrobatic movements. The Capoeira can be performed at different paces, marked by Angola and Benguela.
styles, as well as by São Bento style. The first two are more likely to rely on aerobic energy pathways, while the São Bento style may have either aerobic or anaerobic predominance depending if the practitioners are beginners or advanced, respectively. These styles differ in the specificity of the technique and speed of execution of movements. The physical demand for the practitioners reflects an important and gradual aerobic work, which over time may result, at least for the healthy beginners, in cardiovascular adaptations.

However, to the best of our knowledge, there are no studies investigating the chronic cardiovascular adaptations as a result of participation in an exercise training program composed exclusively by basic Capoeira techniques. The information about the impact of Capoeira on cardiovascular variables may contribute to the body of scientific literature, and exercise prescription aiming for the improvement of the cardiovascular function. So, the present study aimed at analyzing the effects of ten weeks of Capoeira Progressive Training Program on the cardiovascular parameters in male practitioners. A secondary purpose was to present for the first time a suggestion of Capoeira progressive training program focusing the cardiovascular benefits for the practitioners. This way, the hypothesis of this study was that ten weeks of Capoeira progressive training program would decrease resting heart rate and BP and increase HRV in male practitioners.

METHODS:

Subjects

The present study was conducted in accordance to the requirements stipulated in the Declaration of Helsinki and was approved by the Research and Ethics Committee of the Federal University of Vale do São Francisco (protocol 0001/200813 CEDEP). After
signing an informed consent form, 22 apparently healthy men were assessed for this investigation.

The volunteers were assigned into one of the two groups: Capoeira (n=14) or Control (n=08). The allocation of the participants was based on the university’s enrollment records for participation in the basic course of Capoeira and other courses that did not require performing any physical activity over time. Throughout the training protocol, and according to the requirements for satisfaction of study’s participation, 4 participants were removed from the Capoeira Group. As a result, this group was finally composed by 10 volunteers (Figure 1). The main characteristics of the Capoeira and Control groups were 25.4±3.3 and 29.6±6.3 years; 71.9±7.8 and 79.8±12.6 kg; 172.0±5.0 and 174.0±8.0 cm; and IMC of 24.2±2.6 and 26.4±4.0 kg.m²⁻¹, respectively.

** Figure 1 here **

All participants had at least a 24 month period without practicing Capoeira and were requested for not participating in any other physical activity program in parallel to the present study. Participants were required to participate in at least 90% of the experimental sessions of the Capoeira group, in order to be part of the sample. The exclusion criteria of the study were the following: 1) having any kind of bone, muscle or joint impairment that would preclude participating in the study; and 2) having any kind of circulatory or cardiometabolic disease reported in the former health history.

**Cardiovascular evaluation**

Participants from each group were invited to attend the Exercise Physiology Laboratory at Federal University of Vale do São Francisco.
Before and after the ten-week intervention period of Capoeira or Control, the systolic BP (SBP), diastolic BP (DBP), mean arterial pressure (MAP) and heart rate (HR) measurements were performed; the rate pressure product (RPP) was also calculated (SBP * HR). These measurements were performed during 20 minutes, at rest condition (4 measurements every 5 minutes, to produce a representative average result). The BP and HR were verified by an automatic BP monitor (Microlife® model BP 3AC1-1 PC, Widnau, Switzerland). This equipment presents high reproducibility and validity accordingly to the European Society of Hypertension.25

The autonomic nervous system fluctuation was estimated by the HRV indicators from HR R-R interval series records (the time elapsing between two consecutive R waves between cardiac cycles). The investigated indicators were from: 1) linear methods in the time domain, as follows from absolute mean of R-R interval (RRi), square root of the mean of the sum of the squares of differences between adjacent RRi (rMSSD) as a marker of vagal activity, and RRi pairs count differing by more than 50 ms divided by the total number of RRi and multiplied by 100 (pNN50) and; 2) non-linear method analyzed through the Poincaré plotting technique, as follows from standard deviation of instantaneous beat-to-beat RRi variability (SD1) as a marker of vagal activity. All indexes were described by the European Society of Cardiology.5 These indicators of HRV were also analyzed during 20 minutes at resting condition. The RRi series were recorded by the HR monitor (Polar® model RS800CY, Electo Oy, Kempele, Finland) and filtered in the Polar Precision Performance (v. 4.0) software. This equipment offers high reproducibility and validity.26, 27 All analyses were run through the HRV Analysis version 2.0 Kubios software (Biosignal Laboratory, University of Kuopio, Finland).
During the measurement procedures, the participants remained seated on a comfortable chair. The same pre and post intervention apparatus/devices and the same BP checking procedures\textsuperscript{28} and recorded HR/RRi series were adopted.\textsuperscript{5} All measurements performed before and after the interventions, in both groups, were accomplished between 5:00 PM and 6:00 PM at controlled room temperature (22-24\degree C) and the volunteers were in resting state.

The participants of both groups were instructed to maintain their dietary routines during the ten weeks of intervention, as well as during the day of cardiovascular evaluation. Moreover, it was requested to participants do not perform any kind of physical activity and avoid any stress situation that would increase energy expenditure, arousal and thus affect the cardiovascular evaluation.

**Capoeira progressive training program**

The *Capoeira* progressive training program experimental protocol, based in the modern styles of *Capoeira*,\textsuperscript{29} was applied by an instructor with 17 years of experience in teaching *Capoeira* (Figure 2). The protocol followed the directions of the Basic Programmed Lesson, created by Geraldo Pereira d’Santana (*Master Santana*) in a *Capoeira* group called IUNA from the city of São Paulo, Brazil, as described and adapted in Table I. For visualization of the main movements adopted in the Basic Programmed Lesson of *Capoeira* see Figure 2.

**Table I here**

**Figure 2 here**
The experimental protocol for *Capoeira* progressive training program lasted ten weeks and was performed once a week with duration of 90 minutes each. Each session was divided in three parts, being: 1) initial part: consisting of a 15 minutes warm-up with recreational activities at low intensity and/or the “ginga” used in *Capoeira*; 2) main part: following the directions from the Basic Programmed Lesson (55 minutes) and; 3) final part: with a *Capoeira* presentation of approximately 20 minutes. During this last period, the participants remained in a circle and, in pairs, freely executed the movements practiced earlier in the sessions.

In order to perform the Basic Programmed Lesson during the *Capoeira* progressive training program, the activities were divided in four stages (Table I). These stages were composed by main movement that characterizes the *Capoeira* (the “ginga”) and by other movements such as dodging, unbalancing, impact, and acrobatic movements (Figure 2). The model of *Capoeira* progressive training program is described in table II. Usually each sequence of movements during the program was repeated by 30 to 10 times, with 60 to 180 seconds apart, respectively. The technical improvement naturally occurred every week, resulting in a higher speed in movements execution and thus to a gradual increase in training intensity. However, the number of repetitions in each sequence was progressively decreased in parallel to the increase in training intensity.

In an unpublished study from our laboratory, which was conducted with a sample of 16 practitioners (10 male and 06 female), it was observed that the mean intensity of the *Capoeira* basic training was 67±7% of maximum HR (HR\textsubscript{MAX}, as previously measured through an incremental aerobic exercise test). Furthermore, the average rating of perceived exertion (RPE) during the session was 12±2 on the 15-point Borg’s scale that ranges from 6 to 20. During the training session the exercise
intensity changed from the initial part (58±7% HRmax and RPE of 10±2) to the main part (73±7% HRmax and RPE of 14±2) and final part (72±10% of HRmax and RPE of 14±2).

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Statistical analysis

Descriptive statistics with mean and standard deviation were performed. Data normality was verified through an exploratory analysis using a Shapiro-Wilk test. Changes were examined by two-way repeated-measures ANOVA reporting “F-ratio”, “p-value” and “η²” to verify the main effects for interaction of time by group (time*group) and main effects of time (time). When interaction of time by group were found, they were followed by Bonferroni-corrected multiple pairwise comparisons and adjusted “p” values were reported. Student’s t-test for independent samples was performed to compare relative net variations (Δ%) between Capoeira and Control groups. The effect sizes within the intervention were calculated and classified as follows: <0.1 = trivial; 0.1-0.3 = trivial/small; 0.3-0.5 = small; 0.5-0.7 = small/moderate; 0.7-1.1 = moderate; 1.1-1.3 = moderate/large; 1.3-1.9 = large; 1.9-2.1 = large/very large; >2.1 = very large. The power of the sample size was determined using G*Power version 3.1.3, based on the correlation between the magnitudes of change of the analyzed variables. Considering the sample size of this study and an alpha error of 0.05, the statistical power of the experimental group (1 – β), as achieved in present research, was 0.86. The level of significance adopted was set at p<0.05 and the software used for analysis was the IBM SPSS Statistics version 22.0.
RESULTS: Ten weeks of *Capoeira* training totalized 10 experimental sessions with 90 minutes of duration each. The mean value of adherence of the *Capoeira* group during the period of study was 95.0±5.3%.

Repeated measures ANOVA showed a significant main effect of group by time interaction to HR, RRi, rMSSD, SD1, and pNN50 (p<0.05; Table III and IV). A significant main effect of time condition was evidenced to HR, SBP, DBP, MAP, and in the RPP (Table III; p<0.05), RRi, rMSSD, SD1, and pNN50 (Table IV; p<0.05).

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**Table III here**

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It is important to highlight that before the intervention the *Bonferroni*-corrected multiple pairwise comparisons revealed no significant differences between groups for resting HR (p= 0.096), SBP (p= 0.882), DBP (p= 0.585), MAP (p= 0.660), RPP (p= 0.147), RRi (p= 0.170), rMSSD (p= 0.816), SD1 (p= 0.816), and pNN50 (p= 0.927) (Table III and IV).

The effect sizes (ES) within the *Capoeira* intervention were calculated and classified, as follows for HR (ES = 1.10; moderate/large), RRi (ES = 1.39; large), rMSSD (ES = 1.37; large), SD1 (ES = 1.37; large), and pNN50 (ES = 1.29; moderate/large).
DISCUSSION: The main findings of present study were that ten weeks of Capoeira progressive training program, according to the Basic Programmed Lesson method, elicited significant changes in cardiovascular system, including a reduced HR, and increased markers of autonomic parasympathetic tonus such as RRi, rMSSD, SD1, and pNN50 in male beginner practitioners.

Two studies\textsuperscript{19, 20} involving Capoeira and cardiovascular parameters were found in literature, however, none of them presented chronic responses after Capoeira training. As far as we know, this is the first study investigating chronic cardiovascular adaptations to Capoeira progressive training program in male practitioners. The effect size\textsuperscript{30} was calculated and classified as moderate/large to large\textsuperscript{31}, showing that Capoeira progressive training program was effective in improving male's cardiovascular function.

Recently, meta-analysis studies have shown that structured physical training reduces BP.\textsuperscript{3, 4} The present study found non-significant interaction of time by group in SBP, DBP, MAP, and in the RPP. On the other hand, was evidenced the main effect of time for these variables in the Capoeira group (p<0.05). Clinical implications can be highlighted by the results, where chronic reduction of only 2 mmHg, for SBP/DBP, is associated with 6/14\% and 4/6\% decrease in acute myocardial infarction and coronary artery disease, respectively. A decrease of 2 mmHg in BP was also associated with a reduction of 17\% in hypertension prevalence in the general population.\textsuperscript{2} So, the main effect of time on BP becomes even more relevant, especially due to the resting BP of the sample that indicated a pre-hypertension classification before intervention. Neural mechanisms may be related to the drop in BP from chronic adaptations including an increased parasympathetic tone\textsuperscript{18} and or reduced sympathetic nerve activity on resting.\textsuperscript{34} In addition, with a trend of significant interaction of time by group (p=0.06) the present study demonstrated reduction of 12.2\% in RPP after 10
weeks of Capoeira progressive training program, which minimizes cardiovascular risk of silent myocardial ischemia.\textsuperscript{35}

Carlson et al.\textsuperscript{3} showed a discrete reduction in HR (0.79 bpm; p<0.001) associated to the isometric resistance training. These authors suggest that decreased HR is not the main mechanism by which BP reduction may occur after exercise. According to the present study, Capoeira progressive training program enabled for a reduction of 6.6 bpm in participants’ HR. The mechanisms by which chronic exercise training reduces HR and BP have been exhaustively studied,\textsuperscript{18, 34, 37, 38} and include increased resting parasympathetic tone.\textsuperscript{36} Our participants presented a significant increase in markers of parasympathetic tone (rMSSD, SD1, and pNN50) after ten weeks of Capoeira training, what may be of clinical importance. It is well known that central mechanisms may be involved in cardiovascular adaptations to exercise.\textsuperscript{18, 34} However, additional studies are needed to verify and better understand possible mechanisms by which the Capoeira progressive training program may improve autonomic balance and cardiovascular function in different populations (normotensive, prehypertensive, and hypertensive individuals), once the responses to physical training may be varied.\textsuperscript{4}

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Previous findings evidenced that changes in cardiovascular markers have been associated to anthropometric changes after exercise intervention.1, 2, 36 However, for both groups of present study no anthropometric differences were observed pre and post-intervention for body mass ([time*group] F(1, 16) = 0.003; p = 0.959; η² = 0.000), and body mass index ([time*group] F(1, 16) = 0.002; p = 0.961; η² = 0.000).

There are some limitations of the study that may be pointed out, such as: 1) Non BP monitoring over a 24-h period. Such monitoring procedure would lead to information related to BP variability during night and day time, in pre and post-intervention. The importance of BP measurements over 24-h has been well discussed in the emerging literature on cardiovascular function.6 Thus that would be also interesting to have a 24-h BP and HRV responses after the Capoeira progressive training program; 2) The number of participants in the studied groups was not equal; and 3) There was no control of dietary intake and physical activities of participants included in the experimental and control group. However, it was assumed that both groups (Capoeira and Control) followed the recommendation that was to maintain their dietary routines and physical activities during the ten weeks of experiment.

The results of present study do support the conditioning professional with the possibility of using Capoeira progressive training program to promote cardiovascular health in adult practitioners. We recommend to the practitioners and conditioning professionals to follow the Basic Programmed Lesson method, since it encompasses all the movements used in this modality (Table I and Figure 2). The conditioning professional may organize a Capoeira progressive training program to be applied in accordance to table II, where the training sessions may be gradually intensified through the natural gains in the velocity of movements that occur in parallel to the improvement of technique. Finally, in order to participate in a Capoeira training program similar to
the present study, a previous medical screening is recommended, what includes an orthopedic, cardiovascular, and metabolic evaluation.

**CONCLUSION:** In conclusion, ten weeks of *Capoeira* progressive training program, performed once a week according to the Basic Programmed Lesson method, improved markers of cardiovascular function such as reduced HR, and increased HRV indicators in male practitioners.

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TITLES OF TABLES:

Table I. – Basic Programmed Lesson of *Capoeira* divided by stages to apply in the progressive training program.

Table II. – Progressive training program for Basic Programmed Lesson of *Capoeira*.

Table III. – Mean (±SD) of hemodynamic cardiovascular responses and percentual change (Δ%) pre and post-intervention in the *Capoeira* and Control groups.

Table IV. – Mean (±SD) of autonomic cardiovascular responses and percentual change (Δ%) pre and post-intervention in the *Capoeira* and Control groups.

TITLES OF FIGURES:

Figure 1. – Diagram flow for participation in the study.

Figure 2. – The main movements adopted in the Basic Programmed Lesson of *Capoeira*. Images from the instructor of *Capoeira* Training Protocol.
Ten weeks of *Capoeira* progressive training improved cardiovascular parameters in male practitioners

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ABSTRACT

BACKGROUND: The present study analyzed the effects of ten weeks of Capoeira progressive training program on the cardiovascular parameters of male practitioners.

METHODS: Participants were assigned into two groups [Capoeira, n=10; 25.4±3.3 years; 24.2±2.2 kg.m⁻² and Control, n=08; 29.6±6.3 years; 26.4±4.4 kg.m⁻²]. The Capoeira group performed ten weeks of Capoeira progressive training program, being one session per week lasting 90min each. The Control group was instructed to avoid any exercise training program or intense physical activities during the experimental period. The blood pressure (BP), heart rate (HR), and rate pressure product (RPP), as well as HR variability (HRV) indicators were evaluated on resting, before and after intervention.

RESULTS: A two-way ANOVA revealed a main effect of group by time interaction to HR (F=6.649, η²=0.379; p=0.02), and HRV indicators (RRi: F=5.752, η²=0.313; rMSSD: F=4.652, η²=0.283; SD1: F=4.694, η²=0.409, and pNN50: F=5.561, η²=0.360; p<0.05). A main effect of time condition was verified for Capoeira group (p<0.05) on HR (∆= -6.6±6.0 bpm), RRi (∆= 80.1±65.4 ms), rMSSD (∆= 14.1±11.6 ms), SD1 (∆= 10.0±8.2 ms), and pNN50 (∆= 96.2±78.7%). The between groups analysis identified significant differences (p<0.05) for the HR after intervention (Capoeira: -8.6±6.9% vs. Control: -0.7±3.9%). The comparison between Capoeira vs. Control for HRV indicators (RRi: ∆= 10.1±8.5% vs. 0.9±7.6%; rMSSD: ∆= 37.8±32.9% vs. 2.9±31.3%; pNN50: ∆= 96.2±78.7% vs. 0.3±54.1%; and SD1: ∆= 37.7±32.9% vs. 6.5±24.4%; respectively) differed to each other (p<0.05).

CONCLUSION: Our findings showed that ten weeks of Capoeira progressive training program improves both autonomic and cardiovascular parameters in male practitioners.

Key words: Brazilian fight – Chronic effects – Blood pressure – Heart rate variability.
**BACKGROUND:** Lifestyle changes have been recommended for the prevention and treatment of comorbidities associated with cardiovascular risk factors.\(^1^,\)\(^2\) The inclusion of aerobic and dynamic resistance exercise training\(^3^,\)\(^4\) has been currently highlighted as an important strategy for prevention, treatment and control of high blood pressure (BP).

Among the physiological variables associated with BP control, the indicators of autonomic nervous system activity, such as markers of the heart rate variability (HRV), have been shown to be useful for clinical purposes.\(^5^,\)\(^6\) A higher HRV was shown to be associated with lower mortality rates and has been suggested as an important tool on the prevention and early detection of potential cardiovascular diseases.\(^7\)

HRV has also been extensively used as a marker of autonomic adaptation to different exercise modes such as resistance training,\(^8^,\)\(^9^,\)\(^10^,\)\(^11\) aerobic training,\(^9^,\)\(^12\) judo\(^13\) and tai chi chuan.\(^14^,\)\(^15^,\)\(^16^,\)\(^17\) However, there is still a lack in literature regarding the effects of alternative forms of physical training, other than the aforementioned traditional ones.\(^3^,\)\(^4\) It is well-known that every exercise session elicits BP to increase acutely, what in turn may lead to chronical adaptations in cardiovascular system including an increased parasympathetic tone on resting and submaximal exercises\(^18\) what, in turn, may be of special importance to prevent hypertension.

Among the sports eliciting acute cardiovascular adaptations, we can highlight *Capoeira* as a Brazilian martial art/dance that has spread worldwide.\(^19^,\)\(^20\) Such modality is defined as an athletic sport characterized by attack and defense systems, originally created in colonial Brazil.\(^21^,\)\(^22\) Currently, the *Capoeira* is present in more than 150 countries\(^23\) and its practice has been carried out by different social groups over the five continents.\(^24\) *Capoeira* is characterized by its main movement, called “ginga”, and by several others such as dodge, unbalance, impact and acrobatic movements.\(^22\) The *Capoeira* can be performed at different paces, marked by *Angola* and *Benguela* styles,
as well as by São Bento style. The first two are more likely to rely on aerobic energy pathways, while the São Bento style may have either aerobic or anaerobic predominance depending if the practitioners are beginners or advanced, respectively. These styles differ in the specificity of the technique and speed of execution of movements. The physical demand for the practitioners reflects an important and gradual aerobic work, which over time may result, at least for the healthy beginners, in cardiovascular adaptations.

However, to the best of our knowledge, there are no studies investigating the chronic cardiovascular adaptations as a result of participation in an exercise training program composed exclusively by basic Capoeira techniques. The information about the impact of Capoeira on cardiovascular variables may contribute to the body of scientific literature, and exercise prescription aiming for the improvement of the cardiovascular function. So, the present study aimed at analyzing the effects of ten weeks of Capoeira Progressive Training Program on the cardiovascular parameters in male practitioners. A secondary purpose was to present for the first time a suggestion of Capoeira progressive training program focusing the cardiovascular benefits for the practitioners. This way, the hypothesis of this study was that ten weeks of Capoeira progressive training program would decrease resting heart rate and BP and increase HRV in male practitioners.

METHODS:

Subjects

The present study was conducted in accordance to the requirements stipulated in the Declaration of Helsinki and was approved by the Research and Ethics Committee of the Federal University of Vale do São Francisco (protocol 0001/200813 CEDEP).
After signing an informed consent form, 22 apparently healthy men were assessed for this investigation.

The volunteers were assigned into one of the two groups: *Capoeira* (n=14) or Control (n=08). The allocation of the participants was based on the university’s enrollment records for participation in the basic course of *Capoeira* and other courses that did not require performing any physical activity over time. Throughout the training protocol, and according to the requirements for satisfaction of study’s participation, 4 participants were removed from the *Capoeira* Group. As a result, this group was finally composed by 10 volunteers (Figure 1). The main characteristics of the *Capoeira* and Control groups were 25.4±3.3 and 29.6±6.3 years; 71.9±7.8 and 79.8±12.6 kg; 172.0±5.0 and 174.0±8.0 cm; and IMC of 24.2±2.6 and 26.4±4.0 kg.m$^2$(-1), respectively.

**Figure 1 here**

All participants had at least a 24 month period without practicing *Capoeira* and were requested for not participating in any other physical activity program in parallel to the present study. Participants were required to participate in at least 90% of the experimental sessions of the *Capoeira* group, in order to be part of the sample. The exclusion criteria of the study were the following: 1) having any kind of bone, muscle or joint impairment that would preclude participating in the study; and 2) having any kind of circulatory or cardiometabolic disease reported in the former health history.

**Cardiovascular evaluation**

Participants from each group were invited to attend the Exercise Physiology Laboratory at Federal University of Vale do São Francisco.
Before and after the ten-week intervention period of *Capoeira* or Control, the systolic BP (SBP), diastolic BP (DBP), mean arterial pressure (MAP) and heart rate (HR) measurements were performed; the rate pressure product (RPP) was also calculated (SBP * HR). These measurements were performed during 20 minutes, at rest condition (4 measurements every 5 minutes, to produce a representative average result). The BP and HR were verified by an automatic BP monitor (*Microlife*® model BP 3AC1-1 PC, Widnau, Switzerland). This equipment presents high reproducibility and validity accordingly to the European Society of Hypertension.25

The autonomic nervous system fluctuation was estimated by the HRV indicators from HR R-R interval series records (the time elapsing between two consecutive R waves between cardiac cycles). The investigated indicators were from: 1) linear methods in the time domain, as follows from absolute mean of R-R interval (RRi), square root of the mean of the sum of the squares of differences between adjacent RRi (rMSSD) as a marker of vagal activity, and RRi pairs count differing by more than 50 ms divided by the total number of RRi and multiplied by 100 (pNN50) and; 2) non-linear method analyzed through the *Poincare plotting* technique, as follows from standard deviation of instantaneous beat-to-beat RRi variability (SD1) as a marker of vagal activity. All indexes were described by the European Society of Cardiology.5 These indicators of HRV were also analyzed during 20 minutes at resting condition. The RRi series were recorded by the HR monitor (*Polar*® model RS800CY, Electro Oy, Kempele, Finland) and filtered in the Polar Precision Performance (v. 4.0) software. This equipment offers high reproducibility and validity.26, 27 All analyses were run through the HRV Analysis version 2.0 *Kubios* software (Biosignal Laboratory, University of Kuopio, Finland).
During the measurement procedures, the participants remained seated on a comfortable chair. The same pre and post intervention apparatus/devices and the same BP checking procedures and recorded HR/RRi series were adopted. All measurements performed before and after the interventions, in both groups, were accomplished between 5:00 PM and 6:00 PM at controlled room temperature (22-24°C) and the volunteers were in resting state.

The participants of both groups were instructed to maintain their dietary routines during the ten weeks of intervention, as well as during the day of cardiovascular evaluation. Moreover, it was requested to participants do not perform any kind of physical activity and avoid any stress situation that would increase energy expenditure, arousal and thus affect the cardiovascular evaluation.

**Capoeira progressive training program**

The *Capoeira* progressive training program experimental protocol, based in the modern styles of *Capoeira* was applied by an instructor with 17 years of experience in teaching *Capoeira* (Figure 2). The protocol followed the directions of the Basic Programmed Lesson, created by Geraldo Pereira d’Santana (*Master Santana*) in a *Capoeira* group called IUNA from the city of São Paulo, Brazil, as described and adapted in Table I. For visualization of the main movements adopted in the Basic Programmed Lesson of *Capoeira* see Figure 2.

**Table I here**

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The results of RRi, rMSSD, SD1, and pNN50 from the present study indicate that Capoeira, even when performed once a week, may elicit significant increase in parasympathetic tone. While these results corroborate with the observed decrease in HR, BP, and RPP, additional benefits such as lowering psychological stress and anxiety, may occur. The socialization, friendship and relaxation promoted by the Capoeira rhythm together with the effects of exercises and dance \textit{per se}, may also be important to improve autonomic balance and decrease BP. This hypothesis, however, must be investigated in further studies.
Previous findings evidenced that changes in cardiovascular markers have been associated to anthropometric changes after exercise intervention.\textsuperscript{1, 2, 36} However, for both groups of present study no anthropometric differences were observed pre and post-intervention for body mass ([time*group] F(1, 16) = 0.003; p = 0.959; $\eta^2 = 0.000$), and body mass index ([time*group] F(1, 16) = 0.002; p = 0.961; $\eta^2 = 0.000$).

There are some limitations of the study that may be pointed out, such as: 1) Non BP monitoring over a 24-h period. Such monitoring procedure would lead to information related to BP variability during night and day time, in pre and post-intervention. The importance of BP measurements over 24-h has been well discussed in the emerging literature on cardiovascular function.\textsuperscript{6} Thus that would be also interesting to have a 24-h BP and HRV responses after the Capoeira progressive training program; 2) The number of participants in the studied groups was not equal; and 3) There was no control of dietary intake and physical activities of participants included in the experimental and control group. However, it was assumed that both groups (Capoeira and Control) followed the recommendation that was to maintain their dietary routines and physical activities during the ten weeks of experiment.

The results of present study do support the conditioning professional with the possibility of using Capoeira progressive training program to promote cardiovascular health in adult practitioners. We recommend to the practitioners and conditioning professionals to follow the Basic Programmed Lesson method, since it encompasses all the movements used in this modality (Table I and Figure 2). The conditioning professional may organize a Capoeira progressive training program to be applied in accordance to table II, where the training sessions may be gradually intensified through the natural gains in the velocity of movements that occur in parallel to the improvement of technique. Finally, in order to participate in a Capoeira training program similar to
the present study, a previous medical screening is recommended, what includes an orthopedic, cardiovascular, and metabolic evaluation.

CONCLUSION: In conclusion, ten weeks of Capoeira progressive training program, performed once a week according to the Basic Programmed Lesson method, improved markers of cardiovascular function such as reduced HR, and increased HRV indicators in male practitioners.

REFERENCES:
5. European Society of Cardiology. Heart rate variability. Standards of measurement, physiological interpretation, and clinical use. Task Force of the European Society of


TITLES OF TABLES:

Table I. – Basic Programmed Lesson of Capoeira divided by stages to apply in the progressive training program.

Table II. – Progressive training program for Basic Programmed Lesson of Capoeira.

Table III. – Mean (±SD) of hemodynamic cardiovascular responses and percentual change (Δ%) pre and post-intervention in the Capoeira and Control groups.

Table IV. – Mean (±SD) of autonomic cardiovascular responses and percentual change (Δ%) pre and post-intervention in the Capoeira and Control groups.

TITLES OF FIGURES:

Figure 1. – Diagram flow for participation in the study.

Figure 2. – The main movements adopted in the Basic Programmed Lesson of Capoeira. Images from the instructor of Capoeira Training Protocol.
Table I. – Basic Programmed Lesson of *Capoeira* divided by stages.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Movements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt;</td>
<td>1. “Ginga” one time (start with right leg behind);  &lt;br&gt;2. “Esquiva lateral” (“ginga” one time), “esquiva lateral”;  &lt;br&gt;3. “Deslocamento em diagonal” on both sides;  &lt;br&gt;4. “Esquiva básica”, change to “negativa”, “rolê” (ending with right leg behind).</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt;</td>
<td>5. “Ginga” two times;  &lt;br&gt;6. “Meia-lua de frente” (“ginga” one time), “meia-lua de frente”, “armada” (adjusts the left leg in position “paralela”), “Aú simples”;  &lt;br&gt;7. “Ginga” two times (start with right leg behind);  &lt;br&gt;8. “Queixada” on both sides, “negativa invertida”, adjusting the position entering to “esquiva básica”, change to “negativa”, “passada pelas costas”, returning to the position “paralela”;  &lt;br&gt;9. “Ginga” two times (start with right leg behind);  &lt;br&gt;10. “Martelo” (“ginga” one time), “martelo” and “esquiva alta”.</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt;</td>
<td>11. “Ginga” three times (start with left leg behind);  &lt;br&gt;12. “Meia-lua de compasso” (“ginga” one time), “meia-lua de compasso”;  &lt;br&gt;13. “Ginga” three times (start with left leg behind);  &lt;br&gt;14. “Finta de corpo” on single side, “rasteira” to another side (done for both sides);  &lt;br&gt;15. “Ginga” three times (start with right leg behind);  &lt;br&gt;16. “Martelo de chão” done for the left side (ending with left leg behind).</td>
</tr>
<tr>
<td>4&lt;sup&gt;th&lt;/sup&gt;</td>
<td>17. “Ginga” three times;  &lt;br&gt;18. “Rasteira de costas” ending the movement in the “paralela” position, “esquiva básica”, “confronto”, step forward “ponteira”;  &lt;br&gt;19. “Ginga” three times (start with right leg behind);  &lt;br&gt;20. “Esquiva em diagonal” to the left side “Aú-rolê” to the right side;  &lt;br&gt;21. “Ginga” one time (ending with left leg behind).</td>
</tr>
</tbody>
</table>

The descriptions of movements in "quotes" are original names of *Capoeira*. For visualization of the main movements adopted in the Basic Programmed Lesson of *Capoeira* see Figure 2.
Table II. – Progressive training program for Basic Programmed Lesson of Capoeira.

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Intensity</th>
<th>Time</th>
<th>Type of training</th>
<th>Rep/Rec</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; week</td>
<td>Low</td>
<td>15' ✓</td>
<td>Initial part: warm-up&lt;sup&gt;†&lt;/sup&gt;</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>55' ✓</td>
<td>Main part: Development of the “ginga”, “esquiva lateral”, “esquiva básica”, displacement and beginning of the 1&lt;sup&gt;st&lt;/sup&gt; stage of the Basic Programmed Lesson in accordance to table 1</td>
<td>30/60&lt;sup&gt;″&lt;/sup&gt;</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt; week</td>
<td>Low</td>
<td>15' ✓</td>
<td>Initial part: warm-up&lt;sup&gt;†&lt;/sup&gt;</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>55' ✓</td>
<td>Main part: Development of the 1&lt;sup&gt;st&lt;/sup&gt; stage of the Basic Programmed Lesson (Table 1). Began development of other impact (&quot;meia-lua de frente&quot;, &quot;armada&quot;, &quot;queixada&quot; and &quot;martelo&quot;), and acrobatic movements (&quot;Aú simples&quot;)</td>
<td>30/60&lt;sup&gt;″&lt;/sup&gt;</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt; week</td>
<td>Low</td>
<td>15' ✓</td>
<td>Initial part: warm-up&lt;sup&gt;†&lt;/sup&gt;</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>55' ✓</td>
<td>Main part: Beginning of the 2&lt;sup&gt;nd&lt;/sup&gt; stage of the Basic Programmed Lesson (Table 1). Began development of other impact movements (&quot;meia-lua de compasso&quot;, &quot;raspeira&quot; and &quot;martelo de chão&quot;)</td>
<td>30/60&lt;sup&gt;″&lt;/sup&gt;</td>
</tr>
<tr>
<td>4&lt;sup&gt;th&lt;/sup&gt; week</td>
<td>Low to Moderate</td>
<td>15' ✓</td>
<td>Initial part: warm-up&lt;sup&gt;†&lt;/sup&gt;</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>55' ✓</td>
<td>Main part: Development of both the 1&lt;sup&gt;st&lt;/sup&gt; and 2&lt;sup&gt;nd&lt;/sup&gt; stages of the Basic Programmed Lesson and continuation of the 3&lt;sup&gt;rd&lt;/sup&gt; stage of the Basic Programmed Lesson in accordance to table 1</td>
<td>20/90&lt;sup&gt;″&lt;/sup&gt;</td>
</tr>
<tr>
<td>5&lt;sup&gt;th&lt;/sup&gt; week</td>
<td>Low to Moderate</td>
<td>15' ✓</td>
<td>Initial part: warm-up&lt;sup&gt;†&lt;/sup&gt;</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>55' ✓</td>
<td>Main part: Development of both the 1&lt;sup&gt;st&lt;/sup&gt; and 3&lt;sup&gt;rd&lt;/sup&gt; stages of the Basic Programmed Lesson (Table 1). Began development of other impact movements (&quot;rosêira de costas&quot; and &quot;ponteira&quot;), displacements (&quot;confronto&quot; and step forward), dodging (&quot;básica&quot; and &quot;disponível esquivas&quot;) and acrobatic movements (&quot;Ataque&quot;)</td>
<td>20/90&lt;sup&gt;″&lt;/sup&gt;</td>
</tr>
<tr>
<td>6&lt;sup&gt;th&lt;/sup&gt; week</td>
<td>Low to Moderate</td>
<td>15' ✓</td>
<td>Initial part: warm-up&lt;sup&gt;†&lt;/sup&gt;</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>55' ✓</td>
<td>Main part: Development of the 1&lt;sup&gt;st&lt;/sup&gt;, 2&lt;sup&gt;nd&lt;/sup&gt; and 3&lt;sup&gt;rd&lt;/sup&gt; stages of the Basic Programmed Lesson in accordance to table 1</td>
<td>20/120&lt;sup&gt;″&lt;/sup&gt;</td>
</tr>
<tr>
<td>7&lt;sup&gt;th&lt;/sup&gt; week</td>
<td>Moderate</td>
<td>15' ✓</td>
<td>Initial part: warm-up&lt;sup&gt;†&lt;/sup&gt;</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>55' ✓</td>
<td>Main part: Development of the 1&lt;sup&gt;st&lt;/sup&gt;, 2&lt;sup&gt;nd&lt;/sup&gt; and 3&lt;sup&gt;rd&lt;/sup&gt; stages of the Basic Programmed Lesson (Table 1). Began the movements of the 3&lt;sup&gt;rd&lt;/sup&gt; stage (&quot;rosêira de costas&quot; and &quot;ponteira&quot;), displacements (&quot;confronto&quot; and step forward), dodging (&quot;básica&quot; and &quot;disponível esquivas&quot;) and acrobatic movements (&quot;Ataque&quot;)</td>
<td>15/120&lt;sup&gt;″&lt;/sup&gt;</td>
</tr>
<tr>
<td>8&lt;sup&gt;th&lt;/sup&gt; week</td>
<td>Moderate</td>
<td>15' ✓</td>
<td>Initial part: warm-up&lt;sup&gt;†&lt;/sup&gt;</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>55' ✓</td>
<td>Main part: Development of the 1&lt;sup&gt;st&lt;/sup&gt;, 2&lt;sup&gt;nd&lt;/sup&gt; and 3&lt;sup&gt;rd&lt;/sup&gt; stages of the Basic Programmed Lesson. Development of the 4&lt;sup&gt;th&lt;/sup&gt; stage of the Basic Programmed Lesson in accordance to table 1</td>
<td>10/180&lt;sup&gt;″&lt;/sup&gt;</td>
</tr>
<tr>
<td>9-10&lt;sup&gt;th&lt;/sup&gt; week</td>
<td>Moderate</td>
<td>15' ✓</td>
<td>Initial part: warm-up&lt;sup&gt;†&lt;/sup&gt;</td>
<td>-</td>
</tr>
<tr>
<td>1x each</td>
<td></td>
<td>55' ✓</td>
<td>Main part: Development of all four stages of the Basic Programmed Lesson in accordance to table 1</td>
<td>10/180&lt;sup&gt;″&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

**Intensity:** This variable was estimated by speed of movements and changed from slow to moderate speeds during the program; **Type of Training:** The descriptions of movements in "quotes" are original names of Capoeira; **Rep/Rec:** Number of repetition and recovery among repetitions. †The warm-up consists of recreational activities at low and moderate intensity and/or “ginga”. ‡The technical development in final part consists of participants in a circle and, in pairs, freely perform the movements practiced previously in the sessions.
Table III. – Mean (±SD) of cardiovascular variables and their percentual change (Δ%) in relation to pre-intervention for the Capoeira and Control groups.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Time</th>
<th>CONTROL</th>
<th>CAPOEIRA</th>
<th>Main effect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Time*Group</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Time</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F = 6.649</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>p = 0.020</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>η² = 0.294</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F = 9.750</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>p = 0.007</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>η² = 0.379</td>
</tr>
<tr>
<td>HR (bpm)</td>
<td>Pre</td>
<td>68.5±8.3</td>
<td>75.9±9.3</td>
<td>F = 6.649</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>67.8±7.0</td>
<td>69.3±10.2 **</td>
<td>p = 0.020</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-0.7±3.9</td>
<td>-8.6±6.9 ††</td>
<td>η² = 0.294</td>
</tr>
<tr>
<td>SBP (mmHg)</td>
<td>Pre</td>
<td>128.2±6.0</td>
<td>128.8±9.5</td>
<td>F = 0.924</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>125.9±8.9</td>
<td>123.2±9.7 *</td>
<td>p = 0.351</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.7±6.0</td>
<td>-4.2±4.6</td>
<td>η² = 0.055</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>Pre</td>
<td>81.5±5.5</td>
<td>83.4±8.3</td>
<td>F = 0.000</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>78.4±9.9</td>
<td>80.3±7.9 *</td>
<td>p = 0.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-4.0±6.8</td>
<td>-3.6±4.2</td>
<td>η² = 0.338</td>
</tr>
<tr>
<td>MAP (mmHg)</td>
<td>Pre</td>
<td>97.0±4.9</td>
<td>98.5±8.1</td>
<td>F = 0.344</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>94.5±8.9</td>
<td>94.6±8.0 *</td>
<td>p = 0.566</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-2.7±5.7</td>
<td>-3.9±3.7</td>
<td>η² = 0.001</td>
</tr>
<tr>
<td>RPP (mmHg*bpm)</td>
<td>Pre</td>
<td>8765.9±1050.3</td>
<td>9818.4±1707.1</td>
<td>F = 3.813</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>8537.2±1038.0</td>
<td>8615.9±1950.9*</td>
<td>p = 0.069</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-2.3±9.0</td>
<td>-12.2±6.5</td>
<td>η² = 0.192</td>
</tr>
</tbody>
</table>

SBP: systolic blood pressure; DBP: diastolic blood pressure; MAP: mean arterial pressure; HR: heart rate; RPP: rate pressure product. *p<0.05 and **p<0.01 in relation to Pre in the CAPOEIRA group (adjusted p values by Bonferroni-corrected multiple pairwise comparisons); ††p<0.01 for Δ% in relation to CONTROL group.
Table IV. – Mean (±SD) of autonomic cardiovascular responses and their percentual change (Δ%) in relation to pre-intervention for the Capoeira and Control groups.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Time</th>
<th>CONTROL</th>
<th>CAPOEIRA</th>
<th>Main effect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Time*Group</td>
</tr>
<tr>
<td>RRi (ms)</td>
<td>Pre</td>
<td>863.0±98.9</td>
<td>795.2±99.8</td>
<td>F = 5.752</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>867.8±90.2</td>
<td>875.9±130.9*</td>
<td>p = 0.029</td>
</tr>
<tr>
<td></td>
<td>Δ%</td>
<td>0.9±7.6</td>
<td>10.1±8.5†</td>
<td>η² = 0.264</td>
</tr>
<tr>
<td>rMSSD (ms)</td>
<td>Pre</td>
<td>37.8±13.6</td>
<td>39.5±16.9</td>
<td>F = 4.652</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>38.9±19.0</td>
<td>53.7±22.4*</td>
<td>p = 0.047</td>
</tr>
<tr>
<td></td>
<td>Δ%</td>
<td>2.9±31.3</td>
<td>37.8±32.9†</td>
<td>η² = 0.225</td>
</tr>
<tr>
<td>SD1 (ms)</td>
<td>Pre</td>
<td>26.8±9.6</td>
<td>28.1±12.0</td>
<td>F = 4.694</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>28.9±12.7</td>
<td>38.1±15.9*</td>
<td>p = 0.046</td>
</tr>
<tr>
<td></td>
<td>Δ%</td>
<td>6.5±24.4</td>
<td>37.7±32.9†</td>
<td>η² = 0.227</td>
</tr>
<tr>
<td>pNN50 (%)</td>
<td>Pre</td>
<td>18.4±14.7</td>
<td>17.7±15.9</td>
<td>F = 5.561</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>19.7±15.2</td>
<td>28.9±20.3*</td>
<td>p = 0.031</td>
</tr>
<tr>
<td></td>
<td>Δ%</td>
<td>0.3±54.1</td>
<td>96.2±78.7††</td>
<td>η² = 0.358</td>
</tr>
</tbody>
</table>

RRi: absolute mean of R-R interval series; rMSSD: square root of the mean of the sum of the squares of differences between adjacent R-R intervals; SD1: standard deviation of instantaneous beat-to-beat R-R interval variability (Poincaré plot); NN50: R-R interval pairs count differing by more than 50 ms divided by the total number of R-R intervals and multiplied by 100. *p<0.01 to Pre in the CAPOEIRA group (adjusted p values by Bonferroni-corrected multiple pairwise comparisons); †p<0.05; ††p<0.01 to Δ% of CONTROL group.
Figure 1. - Diagram flow for participation in the study.
Figure 2. – The main movements adopted in the Basic Programmed Lesson of *Capoeira*. Images from the instructor of *Capoeira* Training Protocol.