



Effect of volume of participation in exercise programs on biochemical parameters of women

Efeito do volume de participação em programas de exercícios nos parâmetros bioquímicos de mulheres

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DOI

10.12820/rbafs.27e0239



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ABSTRACT

The aim of the study was to evaluate the effect of the volume of participation in exercise programs offered in Primary Health Care (PHC), for 24 weeks on blood biochemical parameters of adult women. Three Basic Health Units in Rio Claro City (São Paulo) were selected and 2 exercise interventions were implemented with different volumes (3 weekly sessions, 90 minutes each; 2 weekly sessions, 60 minutes each). In total, 53 participants remained until the end of the interventions. Regardless of their number of absences, they were divided into 4 groups, according to the volume of participation (calculated individually according to the duration of sessions and the number of classes held), forming groups according to quartiles: Low Volume Group (LVG; 57.62 ± 9.97 years-old), Low Medium Volume Group (LMVG; 56.31 ± 12.18 years-old), High Medium Volume Group (HMVG; 53.00 ± 10.25 years-old), and High-Volume Group (HVG; 59.69 ± 7.66 years-old). Blood biochemical parameters were dosed using the ELISA method. The Generalized Estimation Equation Model was used to compare the biochemical parameters (time, group, and interaction; $p \leq 0.05$). The analysis showed significant and positive time effect for low-density lipoproteins (LDL) and glycemia in all groups and for total cholesterol (TC) in LVG, LMVG and HMVG; a significant group effect for HVG on TC (higher levels compared to all other groups) and LDL (higher levels compared to LVG and LMVG). It is concluded that the physical exercise programs offered in the PHC contributed to a significant reduction in LDL and blood glucose levels, regardless of the volume of participation of individuals in the programs.

Keywords: Physical activity; Primary health care; Risk factors; Community participation.

RESUMO

O objetivo do presente estudo foi avaliar o efeito do volume de participação em programas de exercícios, ofertados na Atenção Primária à Saúde (APS), durante 24 semanas, nos parâmetros bioquímicos sanguíneos de mulheres adultas. Foram selecionadas 03 Unidades Básicas de Saúde de Rio Claro-São Paulo e implementadas 2 intervenções de exercícios com diferentes volumes (3 sessões/semana, 90 minutos cada; 2 sessões/semana, 60 minutos cada). No total, 53 participantes se mantiveram até o final das intervenções, independentemente do número de faltas foram divididos em 4 grupos, de acordo com o volume de participação (calculado conforme a duração das sessões e a quantidade de aulas realizadas de forma individual), formando os grupos segundo os quartis: Grupo Baixo Volume (GBV; 57,62 ± 9,97 anos), Grupo Baixo Médio Volume (GBMV; 56,31 ± 12,18 anos), Grupo Médio Alto Volume (GMAV; 53,00 ± 10,25 anos) e Grupo Alto Volume (GAV; 59,69 ± 7,66 anos). Os parâmetros bioquímicos sanguíneos foram dosados pelo método ELISA. Foi utilizado o Modelo de Equações de Estimações Generalizadas para a comparação dos parâmetros bioquímicos (tempo, grupo e interação; $p \leq 0,05$). A análise evidenciou efeito significativo favorável do tempo para lipoproteínas de baixa densidade (LDL) e glicemia em todos os grupos e para colesterol total (CT) no GBV, GBMV e GMAV; e efeito significativo do grupo para GAV no CT (maiores níveis comparado a todos os grupos) e LDL (maiores níveis comparados ao GBV e GBMV). Conclui-se que o programa de exercício físico ofertado na APS contribuiu para a redução significativa dos níveis de LDL e glicemia, independentemente do volume de participação dos indivíduos nos programas.

Palavras-chave: Atividade física; Atenção básica à saúde; Fatores de risco; Participação da comunidade.

Introduction

Chronic non-communicable diseases (NCDs) are characterized by a set of pathologies with multiple causes and risk factors, representing a major public health problem^{1,2}. Among these diseases are cardiovascular

diseases and their associated factors, such as dyslipidemia, diabetes mellitus, and arterial hypertension³. According to the Pan American Health Organization (PAHO)⁴, more people have died from cardiovascular diseases than from other causes and most of these di-

seases can be prevented by adhering to the practice of physical exercise and regular physical activity (PA)⁵.

Thus, there is an association between cardiovascular health and the regular practice of exercise and PA, which promotes numerous benefits and physiological adaptations linked to this system, such as improving body composition^{6,7}, aerobic capacity, resting heart rate, and blood biochemical parameters^{5,8-13}, such as low-density lipoprotein (LDL), high density lipoprotein (HDL), triglycerides (TG), total cholesterol (TC), blood glucose, and C-reactive protein (CRP). It is known that all these benefits are dependent on a dose-response relationship of physical exercise. Although currently the minimum recommendations for PA are 150 minutes/week, the World Health Organization (WHO) guideline¹⁴ warns countries to develop national health policies and leaves an important message for the population: "Every move counts", evidencing a possible quality of experience for the practice, going beyond "counting minutes". In addition, this document also recommends the adoption of light-intensity PA during the day, emphasizing the importance that every movement counts.

The PA scenario becomes worrying when analyzing the data on their regular practice in Brazil, and that physical inactivity is one of the risk factors that may be responsible for the majority of deaths from NCDs¹⁵. According to data from *Vigitel*¹⁶, in 2019, 44.8% of Brazilian adults did not reach at least 150 minutes of moderate PA per week (leisure time, commuting, and occupational activity).

Thus, it is important to implement public policies aimed at reducing cardiovascular risk factors. The implementation of PA and physical exercise programs in Primary Health Care (PHC) is an action of fundamental importance for the promotion of the population's health¹⁷. In addition, PHC is an advantageous place for the promotion of PA¹⁸, especially when considering that Primary Health Care aims to offer universal access and program actions to prevent diseases.

However, although physical exercise programs are implemented in PHC, many studies evaluating the effects of these interventions do not consider participants who obtain a participation frequency of less than 75% or 80% in exercise sessions, or those who present consecutive absences in the analysis^{10,11,19,20}. However, when it comes to the effect of the physical exercise program, these cutoff points may not reflect the effectiveness of the programs, given that a considerable

portion of the participants do not reach this volume of exercise or participation. Thus, considering real-world problems, it's interesting to analyze the effects of interventions, because the participants excluded due to low participation may also have presented an improvement in some of the parameters studied.

Therefore, it is essential to investigate the volume of participation of all individuals who are included in these interventions, assuming that there is a difficulty in maintaining the adherence of the target audience^{21,22}. The hypothesis of the present study is that even the individuals with a lower volume of participation in the exercise program may benefit from the physical exercise when compared to individuals with a greater volume of participation. Thus, the aim of the present study was to evaluate the effect of the volume of participation in exercise programs offered in PHC, for 24 weeks, on blood biochemical parameters of adult women.

Methods

The current study presents quantitative, quasi-experimental, and longitudinal characteristics. The survey was conducted in 3 Basic Health Units (BHU) in the city of Rio Claro, in the state of São Paulo, which in 2021 had an estimated population of 209,548 habitants and a Human Development Index of 0.803 in 2010²³. The project was approved by the Research Ethics Committee of the Institute of Biosciences of Universidade Estadual Paulista (UNESP), campus Rio Claro, under opinion n° 8594.

Three BHUs that did not deliver any physical exercise intervention, with an adequate infrastructure (space for practice close to BHU and place to store the materials used in the sessions) were included.

After selection of the BHUs, the program dissemination began in places near the units, using pamphlets, banners, newspaper advertisements, and announcements by health professionals at the selected BHU.

In total, 140 registrations were made. The inclusion criteria for study were: age equal to or greater than 20 years, woman and not having limitations that could prevent the practice of physical exercise. Then, 82 women met the inclusion criteria and attended the first sessions of the interventions. Participants who were not included in the study remained in the programs. As exclusion criteria, we considered giving up the program before 24 weeks of intervention ($n = 24$) and individuals who did not attend any blood tests ($n = 5$).

Thus, the final sample of the present study consisted

of 53 participants, who remained until the end of the intervention, regardless of their number of absences in the exercise sessions, divided into four different groups, according to the volume of participation.

Two interventions of physical exercise with different volumes were carried out: one intervention with a frequency of 3 weekly sessions and a duration of 90 minutes each session and one with a frequency of 2 weekly sessions and a duration of 60 minutes each session.

Both interventions were characterized by the same class structure, use of materials, and exercise intensity, differing only in the frequency and duration of the sessions. The physical exercise sessions were divided into an initial part, main part, and final part. The initial part was reserved for the warm-up. In the main part, aerobic exercises (walking, dancing, gymnastics with music) and localized exercises (muscle strength and resistance) were offered, using materials such as gym mats, free weights (plastic bottles with water or sand), brooms, and shin guards. The final part was intended for relaxation (slow walking and final stretching). The initial and final part of the sessions were planned to include light intensity exercise (up to 3 METs) and the main part of light to moderate intensity exercise (up to 6 METs). Vigorous intensity exercises were not prescribed.

Both interventions were delivered by two researchers, graduated in physical education and with experience related to physical exercise programs at PHC. There was no articulation with other health professionals of PHC, in addition to helping publicize the programs.

The volume of participation of each individual was calculated by multiplying the number of classes frequented during the 24 weeks of intervention by the duration of the sessions (60 or 90 minutes).

After the calculation, the volumes were categorized into quartiles, 1st quartile (540 to 2100 minutes) Low Volume Group (LVG, $n = 13$); 2nd quartile (2160 to 2460 minutes) Low Medium Volume Group (LMVG, $n = 13$); 3rd quartile (3240 to 4320 minutes) High Medium Volume Group (HMVG, $n = 14$) and 4th quartile (4410 to 5400 minutes) High Volume Group (HVG; $n = 13$).

Blood biochemical analysis was performed to verify the levels of TC, HDL, LDL, TG, blood glucose, and CRP. The blood samples were collected (10 ml) by a nurse of BHU, after the participant had fasted for 12 hours. In order to preserve the characteristics of the samples, after collection, they were stored in Styrofoam

boxes with ice, sealed, and sent to the Biodynamics Laboratory at UNESP Rio Claro, where the analyses took place. In the laboratory, the collected blood was initially centrifuged and then the serum from this process was separated. After performing this step, the serum concentrations of TC, HDL, LDL, TG, blood glucose, and CRP were determined with commercial kits for measuring these variables, using the ELISA method (enzymatic immune assay).

The body mass index (BMI) was calculated according to the participants' body mass and height ($BMI=Kg/m^2$). Based on the calculation results, individuals with $BMI \geq 30 kg/m^2$ were considered obese. Body mass was obtained using an anthropometric scale (Welmy[®]) and for height a stadiometer was used. The waist-to-hip ratio (WHR) was obtained through waist and hip circumference measurements using a measuring tape (Sanny[®]).

All collected information was recorded in the anamnesis of each participant (applied before the beginning of the intervention), which also included information such as age and self-reported diseases (hypertension and diabetes). In addition, the PA Readiness Questionnaire (PAR-Q) was applied before the beginning of the evaluations.

Blood pressure of all hypertensive participants was monitored once a week, using a digital device (Fuzzy LOGIC[®], BioLand model: 3001), and blood glucose of diabetic participants was measured once a month for insulin-dependent individuals and once every two months for non- insulin-dependent individuals, using a portable glucometer (Advantage[®], Eli Lilly do Brasil Ltda.). These data are not presented as they were used only for monitoring purposes only.

For data presentation, descriptive analysis (mean and standard deviation) was used. To comparison of sample characteristics (continuous variables), one-way ANOVA was used and data normality was tested by the Kolmogorov Smirnov test. The statistical analysis of the blood biochemical parameters in relation to the time, group, and interaction (group x time) effect was performed using the Generalized Estimation Equation Model (GEE), adopting the gamma distribution (considering the quality of adjustment close to zero) and post-hoc comparisons by Bonferroni correction. All statistical analyses were performed using SPSS software, version 25.0, adopting a significance level of 5%. The imputation of data was performed in 5 participants who did not undergo 1 blood test.

Results

The final study sample consisted of 53 participants with a mean age of 56.58 ± 10.15 years. Information about the characterization of the sample, by groups, is detailed in Table 1.

The ANOVA showed a significant difference between groups for BMI ($p = 0.032$), indicating that the BMI of the HMVG was different only from the LMVG (Bonferroni post-hoc, $p = 0.042$). For age and WHR, no significant differences were found between

the groups in the pre-intervention moment ($p > 0.05$).

Table 2 shows the results of the blood biochemical parameters of all groups in the pre- and post-intervention moments and the delta of the assessments. There was no interaction (group*time) for any of the studied variables ($p > 0.05$).

Group effect was found for TC ($p < 0.001$) and LDL ($p = 0.001$). Regarding TC, the analysis showed a difference in HVG in relation to LVG ($p < 0.001$), LMVG ($p < 0.001$) and HMVG ($p = 0.003$). The HVG

Table 1 – Characterization of the sample by group. Data expressed as mean and standard deviation for continuous variables and absolute frequency for categorical variables.

Continuous variables	LVG (n = 13)	LMVG (n = 13)	HMVG (n = 14)	HVG (n = 13)	p - value
Age (years)	57.62 ± 9.97	56.31 ± 12.18	53.00 ± 10.25	59.69 ± 7.66	0.385
BMI (kg/m ²)	28.30 ± 5.58	27.61 ± 6.72	33.70 ± 4.80 [#]	29.59 ± 4.68	0.032*
WHR	1.09 ± 0.07	1.13 ± 0.12	1.06 ± 0.99	1.11 ± 0.05	0.221
Categorical variables	n	n	n	n	
Obesity	4	4	10	5	-
Hypertension	4	4	5	6	-
Diabetes	0	0	2	1	-

Legend: * = significant difference between groups; # = different from LMVG; LVG = low volume group; LMVG = low medium volume group; HMVG = high medium volume group; HVG = high volume group; BMI = body mass index; WHR = waist-to-hip ratio.

Note: Comparisons of continuous variables performed by one-way ANOVA.

Table 2 – Values pre- and post-physical exercise intervention, separated by group according to the volume of participation. Data expressed as mean and standard deviation.

Variables		LVG (n = 13)	LMVG (n = 13)	HMVG (n = 14)	HVG (n = 13)
TC (mg/dl)	Pre	163.60 ± 22.29	169.62 ± 25.79	170.06 ± 40.29	205.46 ± 41.15
	Post	144.31 ± 22.39 [#]	143.85 ± 21.92 [#]	153.07 ± 42.58 [#]	214.54 ± 43.53*
	Δ	- 19.29	- 25.77	- 16.99	+ 9.08
HDL (mg/dl)	Pre	49.23 ± 13.34	52.31 ± 15.55	53.84 ± 13.93	57.77 ± 12.42
	Post	52.54 ± 9.37	53.08 ± 11.99	54.29 ± 11.53	60.69 ± 11.79
	Δ	+ 3.31	+ 0.77	+ 0.44	+2.92
LDL (mg/dl)	Pre	119.19 ± 25.10	129.46 ± 29.05	132.97 ± 29.03	146.85 ± 40.86
	Post	97.08 ± 14.49 [#]	100.62 ± 19.37 [#]	106.71 ± 30.01*	126.92 ± 30.79*
	Δ	- 22.12	- 28.85	- 26.26	- 19.92
TG (mg/dl)	Pre	98.35 ± 62.88	110.15 ± 58.98	115.94 ± 88.46	127.31 ± 62.58
	Post	115.15 ± 61.82	105.31 ± 39.65	128.36 ± 63.22	139.23 ± 84.42
	Δ	+ 16.81	- 4.85	+ 12.42	+ 11.92
BG (mg/dl)	Pre	90.26 ± 22.97	86.77 ± 9.25	103.73 ± 36.98	97.62 ± 14.32
	Post	90.15 ± 14.61*	85.62 ± 6.53*	98.36 ± 24.84*	85.15 ± 16.64*
	Δ	- 0.11	- 1.15	- 5.37	- 12.46
CRP (mg/l)	Pre	3.88 ± 2.30	4.18 ± 2.05	3.84 ± 1.66	3.63 ± 2.20
	Post	3.83 ± 1.81	3.54 ± 1.22	3.64 ± 1.43	2.76 ± 1.43
	Δ	- 0.05	- 0.64	- 0.19	- 0.87

Legend: * = significant difference between pre and post intervention moments; # = significant difference from HVG; LVG = low volume group; LMVG = low medium volume group; HMVG = high medium volume group; HVG = high volume group; CT = total cholesterol; HDL = high density lipoprotein; LDL = low density lipoprotein; TG = triglycerides; BG = blood glucose; CRP = C-reactive protein; Δ = delta (post intervention - pre intervention). Note: Comparisons performed by the Generalized Estimation Equation Model.

showing higher values pre and post intervention compared to all groups. For LDL, the difference was found for HVG in relation to LVG ($p = 0.001$) and LMVG ($p = 0.010$), with HVG also showing higher values pre and post intervention compared to these groups. No statistical differences were found regarding the effect of the group for the variables HDL ($p = 0.143$), TG ($p = 0.548$), blood glucose ($p = 0.157$), and CRP ($p = 0.486$).

There was a positive effect time of the intervention for LDL ($p < 0.001$) and blood glucose ($p = 0.016$), presenting significant decrease in all analyzed groups. Regarding TC, there was also an effect of time ($p = 0.001$), however, the effect was positive for the LVG, LMVG and HMVG (levels decreased significantly) and was negative for HVG (levels increased after the intervention). No statistical differences were found in the time effect for HDL ($p = 0.372$), TG ($p = 0.195$), and CRP ($p = 0.126$).

Discussion

The aim of the present study was to evaluate the effect of the volume of participation in exercise programs offered in PHC, for 24 weeks, on blood biochemical parameters of adult women. The results obtained on the time effect can be considered as one of the most important elements of the study, given that significant differences were found for LDL, blood glucose, and TC.

Regarding LDL levels, all volume of participation groups in the exercise program presented a decrease in post-intervention with emphasis on LMVG ($\Delta = -28.85$), which showed the greatest decrease in it. The literature demonstrates that although the effects of exercise are less evident for LDL levels, it is already known that exercise acts to increase circulation kinetics and prolongs the period in which LDL remains in the reduced form²⁴, thus, these findings may be due to possible greater oxidation of fats caused by exercise²⁵.

It is well established in the literature that exercise is important for blood glucose control and interventional studies focused on lifestyle change have shown significant alterations in fasting blood glucose^{13,26}, thus, all groups in the current study presented decreased blood glucose after the intervention, with a focus on HVG ($\Delta = -12.46$). In addition, it is noteworthy that the greatest decreases occurred in groups with higher volumes of participation (HMVG and HVG), which may be due to the presence of diabetic individuals in these groups, since diabetics are more sensitive to the insulin responses to exercise¹³.

The HVG was the only group that showed an increase in TC levels ($\Delta = +9.08$), with a decrease in values in all other groups after the intervention, as shown in the literature²⁴. TC levels are related to both PA and food intake and this may have been a determining factor for the increase in HVG levels, however, in this study, food intake was neither controlled nor evaluated. Other methodological limitation of the study is the absence of a control group, in addition to other factors that were not controlled, such as a possible practice of PA outside the program, psychological factors and medication use.

Considering the investigation of the effect of participating in an exercise program, the results of the group effect are also relevant, with significant differences in the variables TC, LDL, and blood glucose. The TC level of the group with the highest volume of participation (HVG) was different from the levels of all other groups, with higher pre- and post-intervention values. In LDL levels, the group with the highest participation volume (HVG), also showed higher levels in relation to the two groups with lower participation volumes (LVG and LMVG).

In line with our findings, previous studies such as the one by Lima et al.¹⁰, which compared cardiovascular risk in three groups assisted by the Family Health Strategy, through the practice of physical exercise with a volume of 3 sessions per week and duration of 60 minutes, found results similar to those of the present study, such as decreases in TC and LDL values, while the group considered physically inactive showed increases in these levels. However, it is noteworthy that the intervention was carried out over 12 months, while the intervention in the present study was carried out over 24 weeks. Another study, by Araújo et al.²⁰, evaluated the effects of two physical exercise programs, with 4 weekly sessions and a duration of 60 minutes, over 16 weeks, on health parameters (among them, the biochemical profile) of women attended at a BHU, and obtained similar results to the present study, such as a decrease in blood glucose and TC values in both groups that practiced exercise. It is noteworthy that the aforementioned studies considered participation in less than 75%¹⁰ and 80%²⁰ of the program as an exclusion criterion.

The results did not indicate changes in the TG, HDL, and CRP variables. The literature shows that the TG concentration can change due to the consumption of carbohydrates and fats²⁴, however, variables related to eating habits were not measured in this study. The

literature also indicates that exercise can provide a subtle increase in HDL levels²⁴, however, studies on this topic are still conflicting^{27,28}.

CRP levels may not have changed due to the insufficient time of intervention, since physical exercise interventions performed in PHC lasting 12 months showed a decrease in CRP levels¹¹, however, it is noteworthy that the authors used a cut-off point for the participation of individuals. In addition, in a meta-analysis²⁹ carried out with strength, aerobic, and combined training, it was found that the practice of physical exercise is related to a decrease in CRP levels, however, greater improvements occurred in association with a decrease in BMI.

Importantly, to our knowledge, no studies were found in the literature that aimed to investigate the volume of participation in exercise interventions in PHC. Instead, most interventional studies carried out in PHC do not consider in the analysis participants who do not reach a minimum of 75 to 80% of participation the intervention or who have consecutive absences without prior justification^{10,11,19,20}. Thus, the main finding of our study is that, regardless of the individual's volume of participation in physical exercise interventions in PHC, the benefits of the practice can be remarkable, considering the blood biochemical parameters. This information again remembers to the important message of the WHO guideline¹⁴, as the finding of the present study was in line with the practice of PA regardless of the quantity, reinforcing the theme "Every move counts", mainly aiming at the quality of the experiences.

The evidence found in this study can directly collaborate in the actions of the PHC, mainly for public policies, contributing to the implementation of more PA interventions and reinforcing the importance of adherence in programs regardless of the participation rate. This fact is mainly confirmed by the characteristics of the Unified Health System (SUS), such as the guarantee of universal and free access to health actions, thus, awareness actions for the population, within the context of the SUS, could be effective for the propagation of the importance and practice of PA in PHC, in addition to participation in other health actions. Considering that one of the PHC main objectives is to offer health promotion and disease prevention actions, the delivery of physical exercise and PA programs, health counseling, support groups, among other actions are essential.

As limitations of the present study, we can indicate the absence of a control group in order to allow better comparisons regarding the effect of the intervention, the absence of application of a dietary recall, which would enable analysis of the results of biochemical variables in conjunction with diet and physical exercise. The strengths include the method used to collect the variables (blood biochemical parameters) which is considered a direct method, the duration of the intervention that is longer than other studies in the literature^{8,20,30}, the permanence of 53 participants until the end of the intervention, considered an adequate sample, and the originality of the study, since no other studies were found that assess low participation of individuals in exercise programs in PHC.

The results of this study could contribute to the implementation of public policies focused on health, mainly aimed at the practice of physical exercise, which is directly associated with a lower risk for cardiovascular diseases⁵. In addition, the implementation of programs in PHC was shown to be a viable alternative, as it is an advantageous place for the practice of physical activity¹⁸. In the case of studies carried out in PHC, the difficulty in maintaining adherence of the target audience is considered and, in order to encourage greater participation in the programs, the non-exclusion of participants due to the volume of participation may be a feasible and effective attempt to increase adherence to exercise programs. Furthermore, it is suggested that future research consider the possibility of analyzing the data considering the low volume of participation of individuals.

Thus, it is concluded that the physical exercise program offered in PHC for 24 weeks contributed to a significant reduction in LDL and blood glucose levels and maintenance of HDL, TG, and CRP levels, regardless of the volume of participation of individuals in the program. For TC, there was a significant decrease in the groups with smaller volumes and an increase in the group with higher volume. Thus, the development of exercise programs in PHC seems to be a viable solution for health promotion and disease prevention for all intervention participants, even those with lower attendance. It is suggested that randomized controlled studies be performed to provide better evidence on the proposed theme.

Conflict of interest

The authors declare no conflict of interest.

Funding

The present work was conducted with support from the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES, Institutional Doctoral Scholarship) and the Fundação de Amparo à Pesquisa do Estado de São Paulo - Brasil (FAPESP, Process 2011/15862-2).

Author's contributions

Brunheroti KA, participated in the design and writing of the manuscript, analysis and interpretation of data. Andaki ACR carried out the critical review of the intellectual content. Kokubun E participated in the initial conception of the study and in the critical review of the intellectual content. Papini CB participated in the design of the manuscript, analysis and interpretation of data and critical review of the content.

Acknowledgments

The authors are grateful to the Municipal Health Foundation of Rio Claro, São Paulo and the Physical Activity, Sport and Health Center (NAFES) of the São Paulo State University Júlio de Mesquita Filho.

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Received: 30/09/2021
Approved: 25/12/2021

Quote this article as:

Brunheroti KA, Andaki ACR, Kokubun E, Papini CB. Effect of volume of participation in exercise programs on biochemical parameters of women. Rev Bras Ativ Fis Saúde. 2022;27:e0239. DOI: 10.12820/rbafs.27e0239