

Effects of intensity and modality of community-based exercise programs on mood profile and functional physical capacity in older women under socioeconomic vulnerability: A randomized trial

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Abstract

Background: The prevalence of mood disorders and functional decline among older adults, particularly those under socioeconomic vulnerability, has become a significant public health concern. Physical exercise is widely recognized as a key intervention for improving both physical and mental health in older populations. However, the optimal intensity and modality of exercise for enhancing mood and functional capacity in older women under socioeconomic vulnerability remain unclear.

Objectives: To investigate the effects of the intensity and modality of community-based exercise programs on mood profile and physical functional capacity in older women under socioeconomic vulnerability.

Design: This article presents a prospective, randomized, single-blind study.

Methods: Older women under socioeconomic vulnerability (included: $n=116$; lost to follow-up: $n=28$; analyzed: $n=88$) were randomly assigned to 6 months of high-intensity interval training combined with resistance training ($n=25$), moderate-intensity continuous training combined with resistance training ($n=37$), or resistance training ($n=26$) interventions performed twice weekly. Flexibility (seat and reach), handgrip strength, lower limb muscle strength/power (Five-Time Sit-to-Stand), mobility (Timed Up and Go), aerobic performance (6-min walking), and mood profile (Brunel Mood Scale) were assessed before and during follow-up.

Results: All groups had improved ($p < 0.05$) Five-Time Sit-to-Stand and 6-min walking performance, while high-intensity interval training combined with resistance training and resistance training improved ($p < 0.05$) Timed Up and Go performance. There were also significant improvements ($p < 0.05$) in depression (high-intensity interval training combined with resistance training and moderate-intensity continuous training combined with resistance training), anger (resistance training), vigor (high-intensity interval training combined with resistance training and moderate-intensity continuous training combined with resistance training), fatigue (resistance training), confusion (moderate-intensity continuous training combined with resistance training), and total mood disturbance (high-intensity interval training combined with resistance training, moderate-intensity continuous training combined with resistance training, and resistance training).

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Conclusion: Six months of community-based exercise was effective for improving functional physical capacity and mood profile in older women under socioeconomic vulnerability, regardless of exercise intensity or modality.

Clinical trial registration: RBR-3y8w4w3.

Plain Language Summary

How different types of exercise improve mood and physical ability in older women facing financial hardship summary

This study aimed to determine how different types of exercise—like high-intensity workouts, moderate walking, or strength training—affect mood and physical ability in older women with limited financial resources. The researchers wanted to know if one type of exercise worked better than others for improving well-being and mobility. Older adults, especially those with financial challenges, often face mood disorders and physical decline, which can harm their quality of life. Exercise is known to help, but it's unclear which type is best for this group. Community-based exercise programs are low-cost and accessible, making them a practical solution. In this context, this research may help identify effective ways to support the health of older women in vulnerable situations. The study included 88 older women who were randomly assigned to one of three exercise groups: high-intensity interval training with strength exercises, moderate walking with strength exercises, or strength exercises alone. They exercised twice a week for 6 months. Before and after the program, their mood and physical abilities—like walking speed, balance, and strength—were measured. All three exercise programs improved physical abilities, such as standing up from a chair and walking distance. Mood also improved across all groups, with reductions in feelings such as depression, anger, and fatigue. The key finding was that the type or intensity of exercise didn't matter—all approaches worked equally well. This research also shows that community-based exercise is a simple, affordable way to boost both physical and mental health in older women facing financial hardship. In summary, the study found that any type of regular exercise can help older women feel better and move more easily, regardless of its intensity. It also found that community programs are a great way to make these benefits available to everyone, including vulnerable groups.

Keywords

aged, functional physical performance, high-intensity interval training, mental health, physical exercise, resistance training

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Introduction

Mood is an affective state of an individual, directly reflecting how he/she feels globally and generally within a specific time frame, that fluctuates between positive and negative states.¹ Studies in the field of psychology have demonstrated a direct relationship between an individual's mood state and their physical health, sports, and performance,^{2,3} prevalence of diseases, and even learning situations.^{4,5} In this context, there is an association between mood patterns and behavioral determinants related to health, such as diet,⁶ smoking, consumption of alcohol and other types of drugs, and regular practice of physical exercise.^{7,8}

Additionally, studies have shown that specific populations tend to be more sensitive to changes caused by mood variations.^{9,10} Older individuals are among these populations because of their greater susceptibility to psychological, mood, and anxiety changes, as well as their susceptibility to changes induced by physical exercise.¹¹ Accordingly, studies have shown that older individuals are more susceptible to mood disorder conditions and depression, which can aggravate chronic diseases and directly

impact their quality of life and life expectancy.^{12,13} Socioeconomic status also affects numerous health-related outcomes,^{14,15} mental disorders, and psychiatric conditions.^{16–18} For example, individuals residing in communities with greater socioeconomic vulnerability exhibit significantly higher rates of common mental health disorders (such as depression and anxiety) and a higher prevalence of substance use, as well as reduced access to adequate treatment.¹⁷ Longitudinal and cross-sectional studies have shown that older adults under socioeconomic vulnerability present lower levels of physical and emotional functioning, as well as increased risk of functional decline over time.^{19,20} Several socioeconomic factors—particularly the absence or reduced levels of civic activities, social relationships, and access to essential services—has been associated with higher levels of depressive symptoms, even after adjusting for demographic variables.^{19,20} Thus, interventions to counteract the impact of age and socioeconomic vulnerability on psychological and other health-related outcomes are welcome.

Physical exercise is one of the main behavioral components for improving innumerable health parameters,

including mood across various populations.^{8,21} Although the role of physical exercise is well-known, it is not clear which training model is the most appropriate. For example, a recent systematic review found that it is not clearly established the most effective modality, duration, and intensity of exercise to promote positive mood responses.²¹

Community-based exercise programs are characterized by the application of structured physical exercise to a group of individuals, usually in similar conditions, with the goal of promoting and/or maintaining regular exercise within the community.²² Community-based exercise can be an important strategy to overcome some barriers to regular physical activity, especially among the most vulnerable populations, as it is a low-cost strategy that requires lower financial, material, and human resources than individualized exercise programs.^{22,23}

Previous studies by our group suggest that the intensity and modality of community-based exercise programs can affect the benefits on cardiovascular parameters and functional physical capacity in older women under socioeconomic vulnerability,^{22,23} with the combination of high-intensity interval training (HIIT) combined with strength training being the most effective during a 12-month follow-up.²³ However, to the best of our knowledge, the effect of different intensities and modalities of community-based exercise on mood profile in older women under socioeconomic vulnerability is unknown. Although prior research has consistently demonstrated the positive effects of aerobic exercise on mental health and stress reduction, several knowledge gaps remain unaddressed. For example, a scientometric analysis highlighted significant growth in publications related to aerobics and mental health over the past two decades; however, there is a lack of studies on vulnerable populations such as socioeconomically disadvantaged older women.²⁴ Furthermore, while many studies report overall improvements in mood and reductions in perceived stress following exercise interventions,^{21,25} there is limited understanding of how exercise type (e.g. aerobic, resistance, and/or combined exercise) and intensity (e.g. low, moderate, or high-intensity) influence these outcomes, mainly during community-based programs.

Thus, the present study aimed to investigate the effects of the intensity and modality of community-based exercise programs on mood profile and physical functional capacity in older women under socioeconomic vulnerability.

Methods

Design and population

This is a prospective, randomized, single-blinded study (nested within a larger clinical trial—Brazilian Register of Clinical Trials identifier RBR-3y8w4w3) that analyzed the effect of 6 months of community-based exercise programs of different intensities and modalities on mood variables

and functional physical capacity in older women under socioeconomic vulnerability. This study was conducted and reported following the CONSORT guidelines (Supplemental Material).²⁶ The study included older women registered and regularly attending a Community Service of Coexistence and Bond Strengthening for Older People linked to the Municipal Department of Social Welfare in Bauru. To participate in this service, older women were required to be registered in the Unified Registry for Social Programs of the Brazilian Government and to be referred by the reference team of the Comprehensive Family Care Service from one of the city's Social Assistance Reference Centers. The inclusion criteria for participation in the study were: (1) age >60 years; (2) to be regularly enrolled in and attending one of the Social Assistance Reference Centers; (3) not to be involved in structured exercise programs in the preceding 3 months; (4) to have medical clearance to practice physical exercise; (5) not to have decompensated metabolic and/or cardiovascular diseases; and (6) not to have musculoskeletal, neurological, or pulmonary disorders that could impair participation in the exercise programs. Participants who did not return for post-follow-up evaluations or who did not attend at least 80% of the scheduled exercise sessions were excluded from the final analysis.

The women included underwent anthropometric, mood profile, and functional physical capacity evaluations and were randomly allocated in cluster (at least two clusters per group), using drawing lots, into three groups: (1) HIIT + resistance training (RT; two clusters); (2) moderate-intensity continuous training combined with RT (MICT + RT; three clusters); or (3) RT alone (two clusters). The women then participated in twice-weekly sessions of HIIT + RT, MICT + RT, or RT and were reevaluated after 6 months of follow-up. The primary outcome was mood profile. The secondary outcomes were anthropometrics and physical functional capacity. The flowchart of the study design is presented in Figure 1. The research was approved by the Ethics Committee of the School of Sciences of São Paulo State University under the registration CAAE: 39473120.5.0000.5398. All participants were informed of all procedures and signed the detailed informed consent form before enrolling in the study.

Measurements

Measurements were performed 1 week before (pre) and 1 week later (after) the 6-month intervention, by the same experienced evaluator (blinded to the participant's group assignment), in a temperature-controlled environment (21 °C–24 °C). The assessments included anamnesis (obtaining demographic and health characteristics), body mass and height measurement (Ramuza™ anthropometric scale; Ramuza Indústria e Comércio de Balanças Ltda., Santana do Parnaíba, Brazil), body mass index (BMI) calculation (body mass divided by height squared), functional

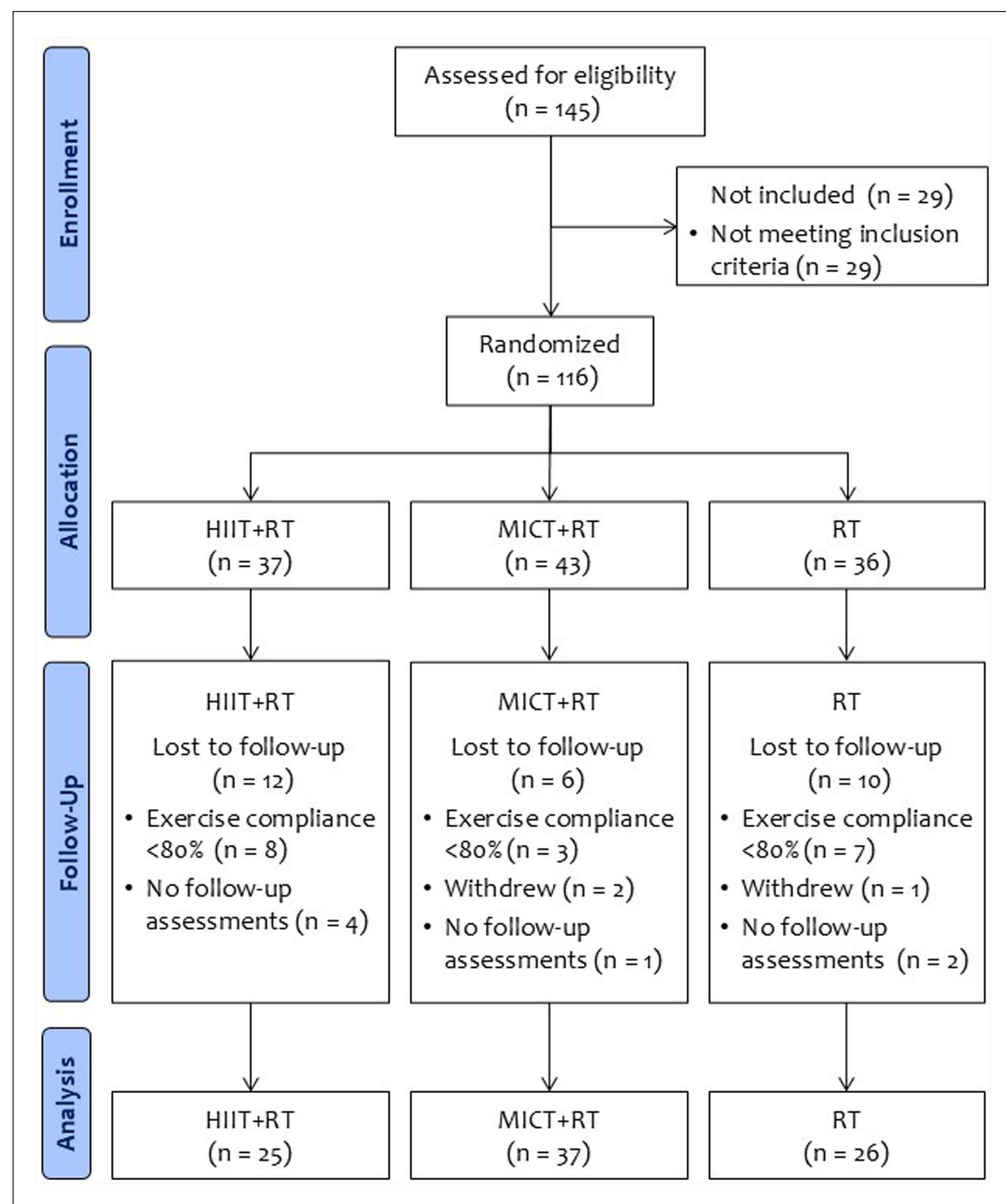


Figure 1. Flowchart of the study design.

HIIT + RT: high-intensity interval training combined with resistance training; MICT + RT: moderate-intensity continuous training combined with resistance training; RT: resistance training alone.

physical capacity evaluation, and assessment of mood state.

Functional physical capacity was assessed by measuring flexibility, handgrip strength, lower limb muscle strength/power, mobility, and aerobic performance, respectively. Flexibility was measured using the sit-and-reach test with a properly calibrated bench, as previously described.^{22,23} Handgrip strength was measured using an analog hydraulic dynamometer (Jamar®; Sammons Preston, Bolingbrook, IL, USA), in triplicate for each hand, and the hand with the highest mean value was used for analysis, as previously described.²⁷ Lower limb muscle strength/power, mobility, and aerobic performance were assessed using the Five-Time Sit-to-Stand (FTSTS) test, Timed Up and Go (TUG) test, and 6-min walking test (6MWT), respectively, as previously described.^{22,23}

Mood profile was evaluated using the Brunel Mood Scale instrument validated for the Brazilian population,²⁸ which is a 24-item questionnaire (on a Likert scale from 0 to 5) that quantifies five negative mood factors (tension, depression, anger, fatigue, and mental confusion) and one positive mood factor (vigor). Each mood factor scores range from 0 to 20. The total mood disturbance (TMD) was then calculated using the formula: $TMD = (tension + depression + anger + fatigue + confusion) - vigor + 100$. The tests and scale used to measure functional physical capacity and mood profile have shown moderate to very-high reliability, validity, and reproducibility.^{28–33}

Interventions

The study participants underwent 6 months of HIIT + RT, MICT + RT, or RT, with structured community-based physical exercise sessions. Before the start of the community-based exercise programs, participants attended an educational program consisting of two lectures on the importance of physical activity for health promotion and how to achieve recommended levels of physical activity.³⁴ During the lectures, participants were introduced to the rating of perceived exertion (RPE) scale,³⁵ which was used to regulate the intensity of the exercise sessions. This method was chosen for intensity regulation due to its low cost and effectiveness for the prescription and regulation of HIIT and MICT sessions in different populations, including older adults.³⁶ All exercise sessions took place in the afternoon and consisted of 5 min of warm-up (mobility and dynamic stretching exercises), 20–50 min of HIIT + RT, MICT + RT, or RT (with volume progressing during the follow-up), and 5 min of cool-down (relaxation exercises and static stretching), as previously described.²²

In brief, the HIIT + RT sessions consisted of 4 min of walking (at nine level of RPE), followed by intervals of 1 min of high-intensity aerobic exercise (brisk walking or jogging at levels 15–17 of RPE), alternated with 2 min of

active recovery (walking at levels 9–11 of RPE), and six resistance exercises (bodyweight squat, push-up on the wall or counter, deadlift with elastic band or stick, elastic band curved or seated row, abdominal crunch on the floor or chair, and elastic band shoulder press or shoulder abduction) at level 15 of RPE. The intensity and type of exercise remained the same throughout the 6 months of training, while the volume of exercises progressed from four HIIT sets (12 min) and one set of 10–15 repetitions of RT (weeks 1 and 2) to: five HIIT sets (15 min) and one set of 15–20 repetitions of RT (weeks 3–5); six HIIT sets (18 min) and two sets of 10–15 repetitions of RT (weeks 6–8); and seven HIIT sets (21 min) followed by two sets of 15–20 repetitions of RT (weeks 9 onwards).

MICT + RT sessions consisted of 4 min of walking at level of RPE, followed by moderate-intensity continuous aerobic exercise (brisk walking at levels 11–13 of RPE) and the same RT exercises and intensity performed by the HIIT + RT group. The intensity and type of exercise remained the same throughout the 6 months of training, and the RT volume progressed similarly to the HIIT + RT group. MICT volume began with 15 min (weeks 1 and 2) and increased progressively to 19 min (weeks 3–5), 22 min (weeks 6–8), and 26 min (weeks 9 onwards). The intensity and volume of HIIT and MICT protocols were based on a previous study, which showed no difference in estimated energy expenditure and total work between HIIT and MICT interventions of this intensity and volume.³⁷

Finally, RT program alone included the same six strength exercises performed by the other groups. The intensity (level 15 of RPE) and the number of exercises remained the same throughout the 6 months of training, while the number of sets and repetitions increased from two sets of 10–15 repetitions (weeks 1 and 2) to: two sets of 15–20 repetitions (weeks 3–5); three sets of 15–20 repetitions (weeks 6–8); and four sets of 15–20 repetitions (weeks 9 onwards).

Statistical analysis

Statistical analysis was performed using SPSS 26.0® software for Windows® (SPSS, Inc., Chicago, IL, USA). The Shapiro–Wilk and Levene tests were used to test normality and homoscedasticity, respectively. Parametric and non-parametric variables were expressed as mean ± standard deviation and median (minimum–maximum), respectively. The chi-square test was used for categorical analysis of the sample data. A two-way ANOVA with repeated measures was used to indicate intra- (pre- and post-intervention) and inter-intervention differences (HIIT + RT, MICT + RT, and RT) for parametric variables. The Bonferroni post hoc test was used to identify significant data indicated by the two-way ANOVA. The Friedman test was used to indicate intra- (pre- and post-intervention) and inter-intervention (HIIT + RT, MICT + RT, and RT) differences for

Table 1. Participants' characteristics at baseline.

Variables	HIIT + RT (N=25)	MICT + RT (N=37)	RT (N=26)	p
Age (years)	73 ± 8	71 ± 7	74 ± 7	0.167
Race (White/Black/Mixed/Indigenous)	11/7/7/0	13/12/10/2	11/7/8/0	0.342
Body mass index (kg)	68.7 ± 6.31	74.2 ± 8.77	68.6 ± 6.89	0.561
Height (m)	1.57 ± 0.13	1.52 ± 0.12	1.59 ± 0.27	0.764
BMI (kg/m ²)	27.6 ± 5.6	31.7 ± 5.0	27.0 ± 9.2	0.443
Comorbidities, n (%)	19 (76)	33 (89)	21 (80)	0.062
Hypertension, n (%)	15 (79)	24 (72)	16 (76)	0.415
Diabetes, n (%)	9 (47)	16 (49)	11 (52)	0.456
Obesity, n (%)	8 (32)	11 (34)	9 (35)	0.579
Other, n (%)	3 (15)	4 (12)	5 (21)	0.057

BMI: body mass index; HIIT + RT: high-intensity interval training combined with resistance training; MICT + RT: moderate-intensity continuous training combined with resistance training; RT: resistance training alone.

Table 2. Functional physical capacity before (pre) and after (post) 6 months of community-based exercise.

Variables	HIIT + RT (N=25)		MICT + RT (N=37)		RT (N=26)	
	Pre	Post	Pre	Post	Pre	Post
Sit and reach (cm)	24.3 ± 1.4	25.7 ± 1.5	22.1 ± 1.1	24.3 ± 1.2	25.7 ± 1.3	26.3 ± 1.4
Handgrip strength (kgf)	23.4 ± 1.1	24.4 ± 1.2	25.2 ± 0.9	25.9 ± 1.0	23.6 ± 1.1	25.6 ± 1.1
FTSTL (s)	11.03 ± 6.24	9.69 ± 0.42*	11.36 ± 0.50	8.87 ± 0.35*	11.81 ± 0.61	8.83 ± 0.42*
TUG (s)	8.42 ± 0.49	6.22 ± 0.40*	8.22 ± 0.40	7.61 ± 0.35	8.63 ± 0.48	6.83 ± 0.42*
6MWT (m)	431.7 ± 8.3	499.9 ± 19.1*	437.1 ± 15.1	470.0 ± 15.7*	415.5 ± 18.0	464.2 ± 18.8*

FTSTS: Five-Time Sit-to-Stand test; HIIT + RT: high-intensity interval training combined with resistance training; 6MWT: 6-min walking test; MICT + RT: moderate-intensity continuous training combined with resistance training; RT: resistance training alone; TUG: Timed Up and Go test. Significant difference from pre in the same group (* $p < 0.05$).

non-parametric variables. The Durbin–Conover post hoc test was used to identify significant data indicated by the Friedman test. The level of significance was set at $p < 0.05$.

Results

One-hundred and forty-five women volunteered to participate in the study between March 1, 2022 and May 30, 2022. One-hundred and sixteen volunteers met the inclusion criteria and underwent pre-intervention assessments. Of these, 18 participants (eight from HIIT + RT, three from MICT + RT, and seven from RT) did not attend at least 80% of the exercise sessions, three (two from MICT + RT and one from RT) dropped out of the study, and seven (four from HIIT + RT, one from MICT + RT, and two from RT) did not complete the post-intervention assessments. Therefore, 88 older women were included in the final analysis (Figure 1). No significant differences between groups were found in any of the participants' characteristics at baseline (Table 1). The prevalence of comorbidities ranged from 76% to 89% across the groups, with hypertension, diabetes, and obesity being the most common conditions. None of the participants had a current diagnosis of depression or were taking antidepressants during the 6 months prior to the end of the study. The

community-based exercise sessions were well tolerated by all participants, and no adverse events were reported during the training sessions in any group. Compliance to the exercise programs among the women included in the final evaluation was similar among groups. No significant changes in body mass or BMI were observed during the 6-month follow-up in any group.

Two-way ANOVA did not indicate any intra–intergroup interaction for any of the functional physical capacity variables. However, ANOVA indicated significant within-group differences for FTSTS ($F_{2, 85} = 3.71$; $p = 0.034$, $\eta^2 = 0.029$, power = 0.30), TUG ($F_{2, 85} = 1.33$, $p = 0.022$, $\eta^2 = 0.015$, power = 0.270), and 6MWT ($F_{2, 85} = 1.63$, $p = 0.001$, $\eta^2 = 0.05$, power = 0.560). Post hoc analysis identified that all groups had improved FTSTS (HIIT + RT: $10.7\% \pm 47.6\%$, $p = 0.02$; MICT + RT: $27.1\% \pm 45.7\%$, $p = 0.001$; RT: $33.7\% \pm 45.2\%$, $p = 0.001$) and 6MWT (HIIT + RT: $7.0\% \pm 4.1\%$, $p = 0.02$; MICT + RT: $13.7\% \pm 4.1\%$, $p = 0.001$; RT: $10.5\% \pm 4.1\%$, $p = 0.002$; Table 2). TUG performance improved only in HIIT + RT ($26.0\% \pm 16.7\%$, $p = 0.001$) and RT ($26.3\% \pm 14.3\%$, $p = 0.002$; Table 2).

Two mood variables (depression and anger) violated the normality distribution, and the Friedman test was applied as an alternative to ANOVA. Two-way ANOVA

Table 3. Mood profile before (pre) and after (post) 6 months of community-based exercise.

Variables	HIIT + RT (n=25)		MICT + RT (n=37)		RT (n=26)	
	Baseline	Follow-up	Baseline	Follow-up	Baseline	Follow-up
Tension	5.76 ± 0.76	6.68 ± 0.81	6.78 ± 0.62	4.28 ± 0.69	9.21 ± 0.98**	6.21 ± 1.08*
Depression	2 (0–12)	1 (0–13)*	4 (0–15)	1 (1–11)*	5 (0–16)	3 (0–13)
Anger	2 (0–10)	1 (0–9)	5 (0–12)	0 (0–13)	3 (0–14)	1 (0–13)*
Vigor	7.92 ± 0.72	10.56 ± 0.65*	8.45 ± 0.59	10.38 ± 0.53*	12.13 ± 0.93**	11.34 ± 0.84
Fatigue	5.41 ± 0.78	6.28 ± 0.70	5.94 ± 0.64	4.37 ± 0.62***	8.01 ± 1.01	5.21 ± 0.98*
Confusion	4.61 ± 0.73	4.2 ± 0.69	4.83 ± 0.61	2.43 ± 0.56*	6.86 ± 0.94	5.01 ± 0.89
TMD	116.44 ± 3.2	111.44 ± 2.25*	118.75 ± 2.66	104.94 ± 2.67*	123.13 ± 4.11**	112.06 ± 4.20*

HIIT + RT: high-intensity interval training combined with resistance training; MICT + RT: moderate-intensity continuous training combined with resistance training; RT: resistance training alone; TMD: total mood disturbance.

Significant difference from pre in the same group (* $p < 0.05$). Significant difference from HIIT + RT and MICT + RT at the same period (** $p < 0.05$).

Significant difference from HIIT + RT and RT at the same period (** $p < 0.05$).

indicated inter-intragroup interaction for tension ($F_{2,85} = 3.70$, $p = 0.030$, $\eta^2 = 0.041$, power = 0.63), vigor ($F_{2,85} = 6.31$, $p = 0.003$, $\eta^2 = 0.070$, power = 0.987), and TMD ($F_{2,85} = 1.46$, $p = 0.007$, $\eta^2 = 0.016$, power = 0.880). ANOVA also indicated a significant intragroup difference for fatigue ($F_{2,85} = 3.31$, $p = 0.050$, $\eta^2 = 0.017$, power = 0.252) and confusion ($F_{2,85} = 4.85$, $p = 0.010$, $\eta^2 = 0.054$, power = 0.675). The Friedman test revealed significant differences for depression ($\chi^2(5) = 7.66$, $p = 0.001$) and anger ($\chi^2(5) = 0.98$, $p = 0.014$). Post hoc analysis identified that the RT showed higher baseline levels ($p < 0.05$) of tension, vigor, and TMD than HIIT + RT and MICT + RT (Table 3 and Figure 2). It also identified significant improvements ($p < 0.05$) in depression in HIIT + RT (−2.3 points) and MICT + RT (−2.5 points), anger in RT (−2.4 points), vigor in HIIT + RT (+3.8 points) and MICT + RT (+3.2 points), fatigue in RT (−3.4 points), confusion in MICT + RT (−3.1 points), and TMD in all groups (HIIT + RT: −5.7 points; MICT + RT: −5.3 points; RT: −8.4 points). Finally, post hoc analysis identified a lower post-intervention level of fatigue ($p < 0.05$) in MICT + RT than in HIIT + RT and RT (Table 3 and Figure 2).

Discussion

The main findings of this study were: (1) all community-based exercise programs were effective for improving FTSTS and 6MWT performance, while only the HIIT + RT and RT were effective for improving TUG performance and (2) all exercise programs were effective for improving mood parameters, although the specific improvements were not the same among groups. To the best of our knowledge, this is the first study to investigate the effect of different community-based exercise modalities and intensities on mood profile in older women under socioeconomic vulnerability.

Previous studies by our group have investigated the effect of different community-based exercise programs in older women under socioeconomic vulnerability.^{22,23} In

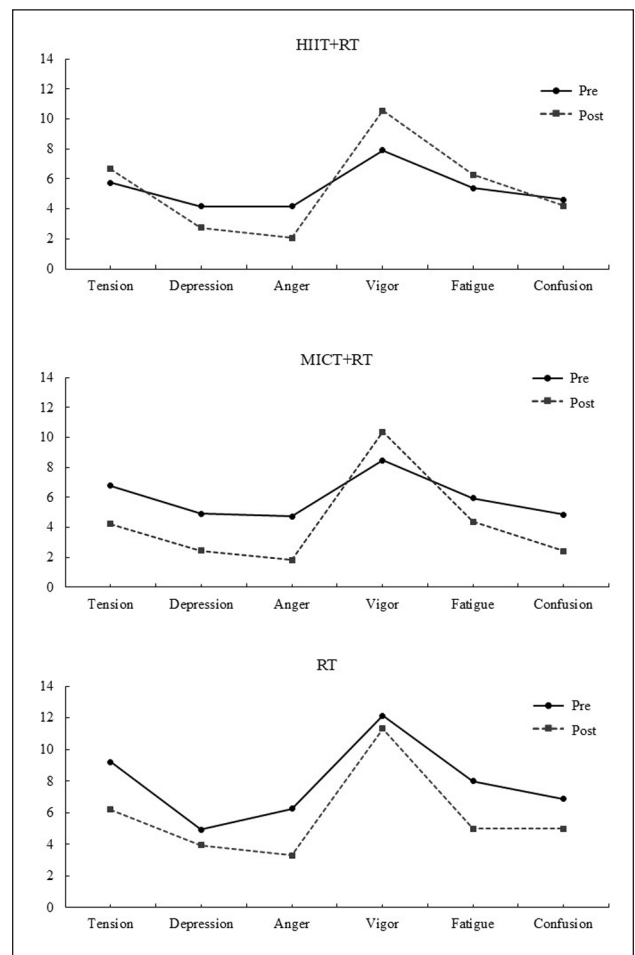


Figure 2. Iceberg profile of mood parameters before (pre) and after (post) 6 months of community-based exercise. HIIT + RT: high-intensity interval training combined with resistance training; MICT + RT: moderate-intensity continuous training combined with resistance training; RT: resistance training alone.

one of these studies, it was shown that HIIT + RT was more effective than MICT + RT and RT for improving functional physical capacity during a 12-week follow-up.²²

In another study, similar to what was observed in the present study, the three interventions (HIIT + RT, MICT + RT, or RT) were equally effective for improving functional physical capacity during a 9-month exercise intervention.²³ Differences in the intervention duration may explain, at least in part, the different findings mentioned above. It is reasonable to suggest that higher intensities of community-based exercise (i.e. HIIT + RT) may be more effective for improving functional physical capacity during shorter interventions (i.e. 12 weeks) in the present population.²² On the other hand, the intensity and modality of community-based exercise do not seem to affect functional physical capacity improvements during longer interventions, as observed in the present study and in the 9-month intervention study.²³

The effect of exercise intensity on mood changes is not yet well established. A recent review suggests that the findings on this topic are not conclusive, showing that moderate and high-intensity aerobic exercises may lead to substantial mood improvements.²¹ On the other hand, it has been suggested that for activities with anaerobic prevalence, moderate intensities appear to be more beneficial than lower and higher intensities for improving mood parameters.³⁸ Exercise session duration also appears to modulate mood improvements, with a tendency toward improvements after 30 min of activity, and with vigor being the primary factor benefiting from session duration.^{39,40} Although session duration was the same in all interventions of present study, only the HIIT + RT and MICT + RF showed improvements in vigor during follow-up. However, RT already had higher baseline vigor levels compared with the other groups, which may explain the lack of improvement during follow-up.

Regarding negative mood parameters, the present study showed that HIIT + RT and MICT + RT were effective in reducing depression and TMD scores, while confusion score was reduced only in MICT + RT. On the other hand, RT showed reductions in tension, anger, fatigue, and TMD scores during the 6-month follow-up. Although the number of negative mood parameters improved after RT was greater than after the other interventions, the higher baseline levels of anger and fatigue in the RT may explain this difference. Thus, the findings of this study do not suggest that the intensity or modality of exercise affects the benefits of community-based exercise programs on mood profile in older women under socioeconomic vulnerability.

The present mood parameters improvement found after all interventions suggest that exercise can be an effective low-cost strategy for improving mental health in older women under socioeconomic vulnerability. Several neurophysiological and psychosocial mechanisms may be involved in these mood benefits in response to exercise. For example, it is known that both stress and reward systems are affected by exercise, with a certain stress threshold needing to be exceeded for the activation of

hypothalamic–pituitary–adrenal axis.^{21,41} Furthermore, exercise can increase BDNF, a key neurotrophin for structural and functional brain stimulation and alteration.^{42,43} Additionally, psychosocial constructs are linked to a better relationship between well-being, self-esteem, and sense of belonging.^{44,45} Lastly, contextual and personal factors may directly affect the effects of exercise on mood, and further investigations are necessary to understand these phenomena in the exercise-induced changes on mood and behavior.

In this context, current evidence underscores that not all physical activity has the same psychological impact, showing that leisure-time physical activity yields significantly greater psychological benefits than occupational physical activity, largely because of factors such as autonomy, intrinsic motivation, and less stressful contexts.⁴⁶ These findings suggest that the voluntary and enjoyable nature of leisure-time exercise might enhance its effectiveness in promoting mental health, particularly in populations exposed to high psychosocial stress. Moreover, contextual and personal factors may directly affect the effects of exercise on mood, as highlighted in a previous study that explored the complex interplay between mood, emotional intelligence, personality traits, and subjective health.⁴⁷ Their results showed that individuals with higher emotional intelligence and positive personality traits, such as extraversion and emotional stability, tend to report better mood states and greater perceived well-being. Importantly, emotional intelligence appears to act as a mediator between personality and subjective health, suggesting that emotional skills may amplify the mental health benefits of physical activity. Together, these findings reinforce the notion that both the context in which exercise occurs, and individual psychological characteristics play crucial roles in shaping the mental health outcomes of physical activity interventions. This highlights the importance of designing exercise programs that are not only physiologically effective but also psychologically engaging and tailored to personal and contextual factors, especially among socioeconomically vulnerable populations.

This study also has important clinical implications. Lower limb functional capacity (e.g. FTSTS and TUG performance) is associated with mortality, hospitalization, daily living dependency, and disability.^{48,49} Aerobic capacity seems to be a stronger predictor of cardiovascular and all-cause mortality than other established risk factors (e.g. smoking, hypertension, high cholesterol, and type 2 diabetes mellitus).⁵⁰ Thus, the present improvements in FTSTS, TUG, and 6MWT found after training in all groups suggest that community-based exercise is a simple and inexpensive tool that may impact prognosis in older women under socioeconomic vulnerability, independently of their type (i.e. combined or resistance) and intensity (i.e. HIIT or MICT). In addition, the inclusion of such group-based exercise programs not only improves participants' functional physical capacity and mental health but also

promotes greater social cohesion and inclusion, suggesting that it can be a crucial strategy for promoting physical and mental health, and improving quality of life at older age.

Study limitations

Some limitations of the present study should be acknowledged. First, the weekly exercise frequency was lower than that proposed by the physical activity guidelines,⁵¹ and it is possible that different results may be observed in individuals performing the same protocols with higher weekly frequencies. Moreover, the sample size calculation was not performed due to the lack of previous studies on the subject, and we thus cannot rule out that the benefits found could be better shown with a larger sample size. The exclusion from the final analysis of women with <80% of compliance to the proposed exercise sessions is also a limitation because low adherence may negatively affect the observed results. Therefore, the results of this study cannot be extrapolated to compliance levels lower than those observed in this study. As previously discussed, the lack of similar levels between groups in some mood parameters at baseline may have influenced some changes during follow-up (i.e. the lack of tension improvements in HIIT + RT and MICT + RT, and vigor improvements in RT). The present sample size and study design does not allow us to test if these lack of changes were associated with its baseline, according to our hypothesis. Thus, future studies with higher sample sizes are welcome to confirm this hypothesis.

Another aspect that should be acknowledged is the high dropout rate. However, this factor may be better understood considering the characteristics of the study population. Previous studies show that individuals under socioeconomic vulnerability tend to show low adherence to exercise-based interventions, with dropout rates exceeding 50%.⁵² Among older adults, the prevalence of regular engagement in physical exercise is nearly 30%.⁵³ In the present study, it was observed a 26% dropout during follow-up, with the exercise groups having an 84% of exercise compliance, which is notably higher than what is typically expected for this population, as previously reported. This finding may be directly associated with factors such as personalized interventions, continuous support, reduction of logistical barriers, the promotion of perceived health benefits, and the positive aspects of social interaction.^{52–54}

Conclusion

In summary, the findings of the present study suggest that 6 months of community-based exercise can be an effective low-cost strategy for improving functional physical capacity and mood profile in older women under socioeconomic vulnerability. The results also suggest that the intensity

and modality of exercise do not affect the benefits of community-based exercise on the variables investigated in the present population.

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Ethical considerations

This study was approved by the Research Ethics Committee of the School of Sciences of São Paulo State University (CAAE 39473120.5.0000.5398) and conducted following the Declaration of Helsinki.

Consent to participate

All participants provided written informed consent.

Consent for publication

All authors approved the final article and consent to publication.

Author contributions

Gabriel de Souza Zanini: Article drafting; Contributed to conception; Data acquisition; Design.

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Data availability statement

Data supporting this study's findings are available from the corresponding author upon reasonable request.

Supplementary material

Supplemental material for this article is available online.

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