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Effect of combined aerobic and resistance training with self-selected intensity on clinical parameters and fitness in a patient with mixed anxiety and depressive disorder: a case report

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Abstract

Background This case study assessed the effects of a combined aerobic and resistance training intervention with self-selected exercise intensity in a patient with mixed anxiety and depressive disorder.

Case presentation A 24-year-old Brazilian female patient (1.57 m, 62.6 kg), sedentary, with a clinical diagnosis of mixed anxiety and depressive disorder (F41.2 according to ICD-10) for 9 months participated in this case report study. Aerobic exercise and resistance exercise were performed within the same session, 5 days/week for 8 weeks. The physiological demand (heart rate), load, and psychophysiological responses were measured during the training sessions. Training compliance was 64.3% and self-selected exercise intensity was moderate for aerobic exercise and light for resistance exercise. Exercise sessions were subjectively perceived as pleasant and of moderate intensity. There were clinically significant improvements in depressive symptoms (ΔBeck Depression Inventory-II = −15), trace anxiety (ΔState-Trait Anxiety Inventory = −25), sleep quality (ΔPittsburgh Sleep Quality Index = −8), quality of life (ΔWorld Health Organization Quality of Life Questionnaire-Brief: +33.7), and depressive status assessed by a psychiatrist. Aerobic fitness (+7.7%) and muscle strength (+13.5%) improved after the 8 weeks of training.

Conclusion Combined aerobic and resistance exercise with self-selected exercise intensity is a promising tool for improving clinical and fitness outcomes in patients with mixed anxiety and depressive disorder. While this case report offers valuable preliminary insights, further research featuring larger samples, control groups, robust study designs, extended intervention durations, and comprehensive follow-up assessments is essential to substantiate these findings.

Keywords Exercise, Depression, Mental health, Resistance training

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Background

Both aerobic (AE) and resistance exercise (RE) have been shown to be effective in improving depressive symptoms both as a standalone or adjunctive intervention [1–3]. In this regard, the current model of imposed-based exercise prescription (especially the exercise intensity) may be a limiting factor for exercise adherence, especially considering the emotional and physical characteristics of patients with depression. It has been shown that approximately 60% of healthy individuals abandon exercise in the first 3 months, 70–80% abandon over 6 months, and less than 15% remain for more than 12 months [4, 5]. In patients with depression, exercise compliance varies from 50% to 100% [3]. In fact, for exercise to be beneficial for people with depression, the "pill" should be taken [6]. In this regard, effort should be made to engage patients in exercise in the "real world," which is especially difficult in psychiatric patients [6, 7].

Acute exercise increases physiological signaling (i.e., heart rate, respiratory frequency, volume, muscle fatigue) and perceived exertion, which may result in feelings of tiredness and unpleasantness. The hedonic theory of motivation proposes that the affective responses (pleasure/displeasure) are paramount to determining the likelihood of approaching or withdrawing behavior. In fact, affective responses to exercise have been shown to predict future exercise behavior in individuals without psychiatric conditions [8, 9]. Therefore, unpleasant exercise experiences may result in individuals refraining from exercise. This may be worsened by the imposed-based model of exercise prescription.

In this regard, based on the self-determination theory, which proposes the need for autonomy as a basic psychological need [10], a new model of exercise intervention was proposed in which the individual can determine their exercise intensity (self-selected intensity; SSI) [10, 11]. This results in improved psychological responses such as the increased perception of control, perceived choice, and affective responses [10]. Hence, this model of exercise prescription may be an interesting alternative to the current model of imposed-based exercise prescription for patients with psychiatric conditions such as depression. In the present case report, we tested the effects of a combined aerobic and resistance training intervention with self-selected intensity on the clinical and fitness parameters of a patient with mixed anxiety and depressive disorder (MADD) in a practical setting.

Case presentation

A 24-year-old Brazilian female patient (1.57 m, 62,6 kg), sedentary, with a clinical diagnosis of MADD (F41.2 according to ICD-10) for 9 months. The patient was undergoing psychological treatment for 1 year, once a week, with an occasional second weekly session. She was accompanied by a psychiatrist for 9 months, with one consultation every 2 months. She was taking regular doses of fluoxetine hydrochloride (40 mg/day) and, in case of crisis, up to 0.5 mg/day of clonazepam. In addition, in crisis situations, the patient took two doses of sublingual clonazepam 0.25 mg (indicated for immediate and episodic use) at two different times on the day of the crisis, reaching a total dose of 0.5 mg/day. The patient had a consultation and a stress test with a 12-lead electrocardiogram performed by a cardiologist and received clearance prior to starting the intervention. In the evaluation with the cardiologist, the patient reported being asymptomatic, with no history of precordial pain, valvular heart disease, myocardial revascularization, myocardial infarction, or coronary angiography. She also had no diagnosis of other clinical conditions or risk factors such as diabetes mellitus, smoking, hypertension, dyslipidemia, or obesity. The patient also presented in the cardiac examination with regular cardiac rhythm in two heart sounds and normophonic heart sounds without murmurs. During the exercise stress test, the effort response was maximal (reaching 100% of the predicted maximum heart rate), with a physiological blood pressure response, no arrhythmias, good exercise tolerance, and results incompatible with myocardial ischemia. All procedures performed in the present study were conducted following the Declaration of Helsinki and were approved by the Institutional Review Board (protocol number: 488.110), and written informed consent was obtained from the patient.

Exercise training took place in a regular commercial gym (i.e., not in a university or hospital setting), 5 days a week for 8 weeks. The AE was performed continuously on a treadmill with a prescribed duration (25 min) and intensity (i.e., speed) self-selected by the patient [12]. The RE was performed with nine exercises for the major muscle groups of upper limbs and trunk (seated row, seated bench press, biceps curls, triceps pushdown, and abdominal crunches) and lower limbs (horizontal hack machine, knee extension, laying knee flexion, and seated calf raise), alternating by segment in different days. For RE, the patient was required to perform two sets of 15–20 repetitions, with 90 second intervals. The load for each exercise was self-selected by the patient [13]. Both AE and RE were performed within the same session, with AE before RE in the first 4 weeks and the opposite order for the rest of the intervention. All training sessions were accompanied by a personal trainer that did not interfere

in the speed or weight selection. The heart rate (HR) was continuously measured during AE (FT1, Polar Electro, Kempele, Finland) and the patient reported the ratings of perceived exertion (RPE; OMNI-WR 0–10 scale [14]) and the affective responses (Felling Scale, FS, +5/−5 [15]) every 5 minutes. During RE, the number of repetitions, load RPE (OMNI-RES 0–10 scale [16]), and affective responses were registered after each set.

Approximately 2 weeks before (T0) and 2 weeks after (T8) the 8-week intervention the patient underwent a comprehensive assessment of clinical and physical fitness parameters (Fig. 1). Depressive symptoms were assessed using the Beck Depression Inventory (BDI-II), trait anxiety using the State-Trait Anxiety Inventory (STAI), quality of sleep using the Pittsburgh Sleep Quality Index, daily sleepiness by the Epworth Sleepiness Scale (ESS), and quality of life (QOL) using the World Health Organization Quality of Life Questionnaire (WHOQOL-Bref). All questionnaires were self-administered. The patient also visited the psychiatrist for an assessment before and after the intervention. The aerobic fitness was assessed using an incremental maximal treadmill test (Bruce protocol) and muscle strength using a one-repetition maximum test (1RM) for the same eight REs, following standard procedures.

Results

The intervention was well-tolerated, with no side or adverse effects being reported. The training compliance was 64.3% and the self-selected exercise intensity was moderate (53.1 ± 9.8% of HR reserve) for AE and light (45.7 ± 10.3% of 1RM) for RE (Fig. 2). RPE was indicative of moderate intensity (5.00 ± 1.95) for both AE and RE and exercise was perceived as pleasant (2.87 ± 1.48 on the FS, from "+1 = fairly good" and "+3 = good"), despite oscillation within and between sessions (Fig. 3).

After the intervention, both muscle strength (+13.5%) and aerobic fitness (+7.7%) improved (Table 1). More importantly, there were clinically significant improvements in depressive symptoms, trace anxiety, quality of sleep, daily sleepiness, and quality of life as well as the depressive status assessed by a psychiatrist (Table 2).

Discussion

The present case report demonstrated the feasibility of combining AE and RE with self-selected intensity in a patient with MADD. Moreover, there were remarkable improvements in depressive symptoms, trait anxiety, quality of sleep, and quality of life, which were confirmed by a psychiatrist assessment. It is noteworthy that the changes in BDI-II and STAI were higher than the minimal clinically important difference [17, 18]. Finally, physical fitness also improved after the intervention. Therefore, despite the limitations in the generalization of a case study, the results of the present study are in line with pragmatic randomized controlled trials [19–21].

Adherence to exercise training is a challenge faced in many populations, which is no different for patients with depression. In addition, exercise is of no good if it is not performed [6]. One possible explanation is the unpleasant experiences with exercise owing to the increased physiological demand (i.e., cardiovascular, respiratory, muscular) and the sensation of tiredness. These unpleasant sensations may be exacerbated in psychiatric patients,

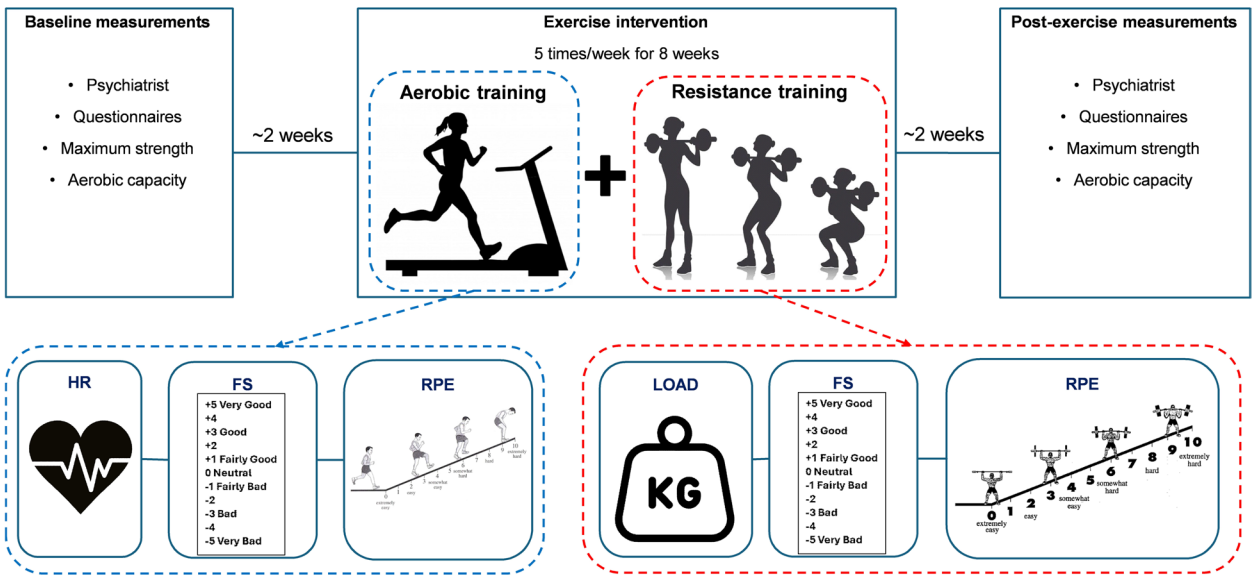

Fig. 1 Study flow chart. *HR* heart rate, *FS* Felling Scale, *RPE* ratings of perceived exertion. The figure is original and made by the authors

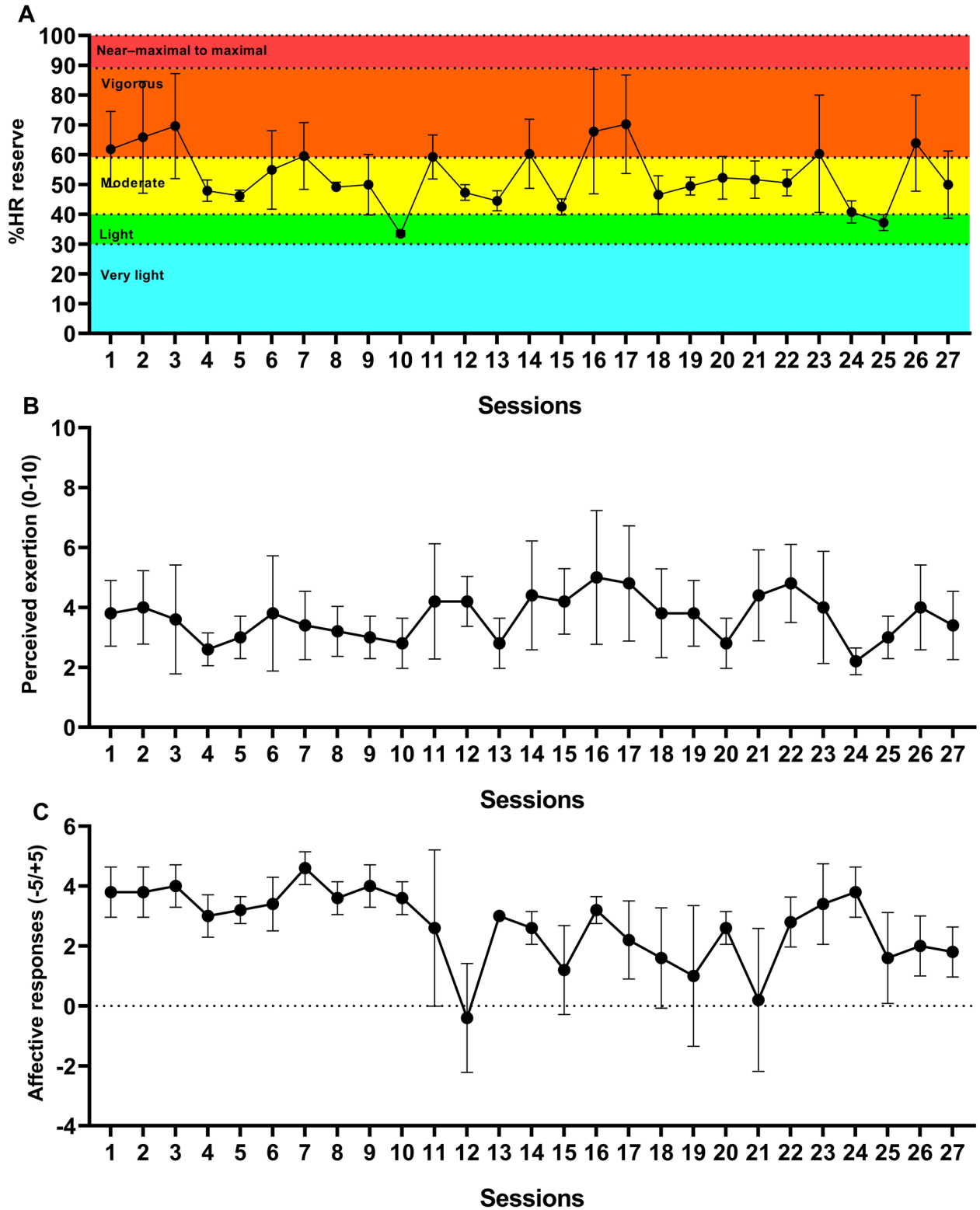

Fig. 2 Physiological demand (percentage of heart rate reserve) (**A**), ratings of perceived exertion (**B**), and affective responses (**C**) measured every five minutes during aerobic exercise with self-selected intensity throughout the 8-week intervention in a patient with mixed anxiety and depressive disorder. Note: the zones of exercise intensity were based on the guidelines of the American College of Sports Medicine [22]

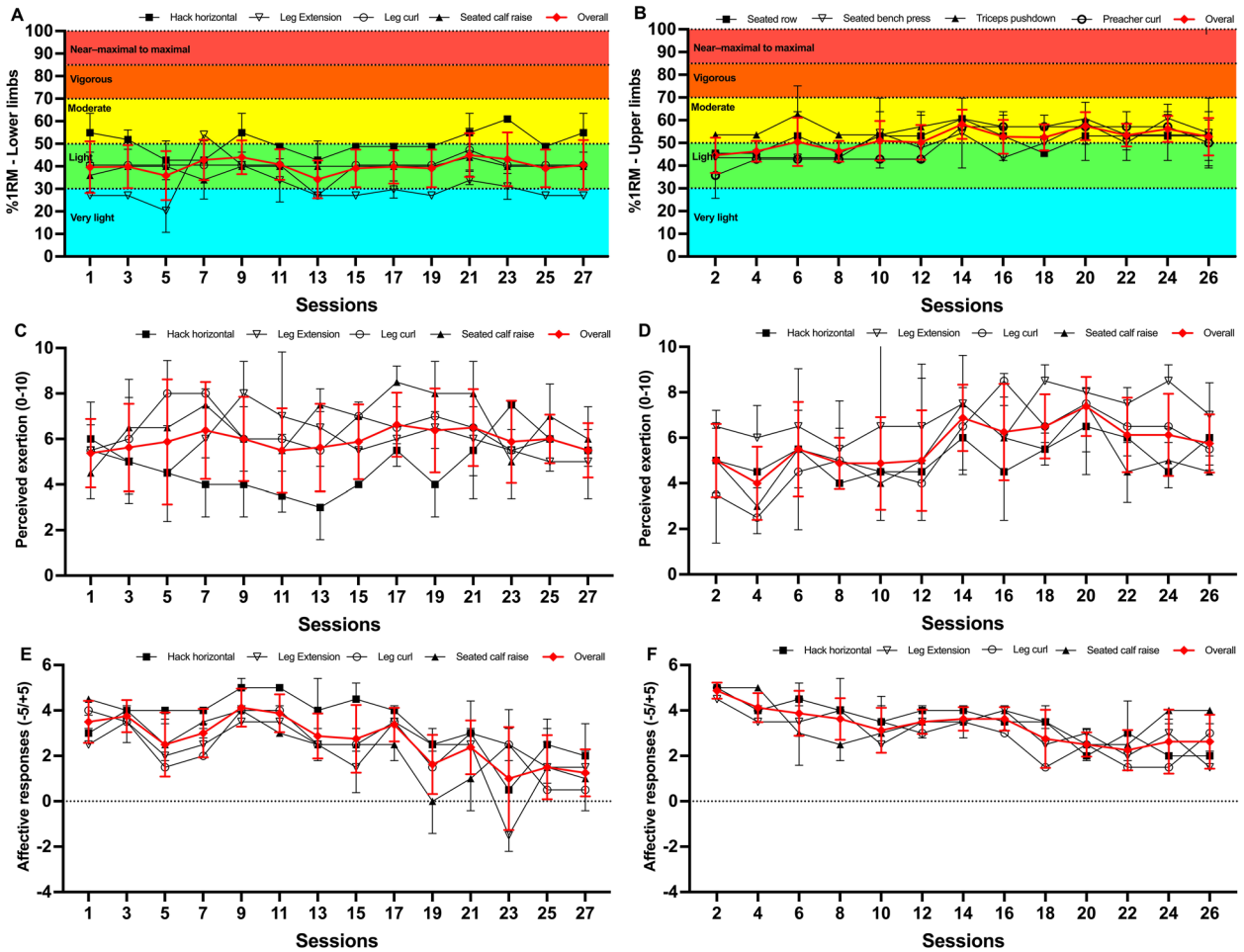

Fig. 3 Percentage of one-maximum repetition (**A** and **B**), ratings of perceived exertion (**C** and **D**), and affective responses (**E** and **F**) for lower (left column) and upper body (right column) measured after every set of resistance exercises with self-selected intensity throughout the 8-week intervention in a patient with mixed anxiety and depressive disorder. Note: the zones of exercise intensity were based on the guidelines of the American College of Sports Medicine [22]

especially those with depressed mood and affect. Furthermore, the lack of choice is a marked characteristic of the current exercise prescription, in which individuals are told what to do, for how long, how many times, and how much weight/load or speed should be used. Moreover, the idea of "no pain no gain" that is widespread in the exercise setting may drive people away from practicing it, especially individuals with depression.

In this regard, self-selected exercise intensity allows individuals to determine their exercise intensity, which is normally guided by the level of pleasure. This approach fosters perceived autonomy, locus of causality, perceived choice, volition, interest, and enjoyment compared with imposed exercise, even if the imposition is the same as the intensity self-selected [10]. In fact, the patient reported, on average, a positive affective response to exercise (+1 to +3 on the FS, "fairly good" to "good"), which represents that she was adjusting the intensity to maintain the exercise at pleasant levels. In addition, despite the low intensity in RE, the patient reported a perceived exertion of moderate intensity, which suggests that if a recommended load was imposed her RPE levels would be at higher levels that, ultimately, would result in unpleasant responses and discourage her from exercising.

Interestingly, Callaghan *et al.* [20] over one decade ago compared the effect of an intervention with AE at preferred (self-selected) and prescribed (imposed) intensity (3 times/week for 4 weeks) in 38 women with depression. They found that exercise at the preferred exercise intensity provided greater antidepressant effects than the prescribed intensity (mean change in BDI = −8 versus −0.9, respectively) [20]. Moreover, participation rates were higher in the preferred than prescribed exercise intensity group (66% versus 50%, respectively). A secondary

Table 1 Muscle strength and aerobic fitness before and after intervention in a patient with mixed anxiety and depressive disorder

Variable		Pre	Post	Change (raw)	Change (%)
Muscle strength					
	Seated row (kg)	33	37	4	12.1
	Seated bench press (kg)	23	25	2	8.70
	Preacher curl (kg)	7	8	1	14.3
	Triceps push-down (kg)	28	32	4	14.3
	Hack horizontal (kg)	82	92	10	12.2
	Leg extension (kg)	37	45	8	21.6
	Leg curl (kg)	37	40	3	8.10
	Seated calf raise (kg)	50	56	6	12.0
Aerobic fitness					
	Time to fatigue (min)	13	14	1	7.7

Table 2 Clinical measures before and after intervention in a female patient with mixed anxiety and depressive disorder

Variable	Pre	Post	Change (raw)	Change (%)
BDI-II	29	14	− 15	51.7
STAI-T	64	39	− 25	39.1
PSQI	16	8	− 8	50.0
ESS	15	7	− 8	53.3
QOL (%)	39.4	73.1	33.7	85.5

Note BDI Beck Depression Inventory, *STAI-T* State-Trait Anxiety Inventory, *PSQI* Pittsburgh Sleep Quality Index, *ESS* Epworth Sleepiness Scale, *QOL* quality of life

analysis of the same pragmatic randomized controlled trial (RCT) showed that approximately one-third of the patients in the preferred exercise intensity group presented scores consistent with recovery from depression [21]. In another pragmatic RCT, Doose *et al.* [19] found a large reduction in depressive symptoms assessed by the Hamilton Rating Scale for Depression (Cohen's d: 1.8; mean change 8.2) and a moderate effect on BDI-II (Cohen's d: 0.50; mean change: −4.7) after 8 weeks of AE with self-selected intensity exercise in patients with unipolar depression, but no change in physical fitness.

In the present report, we combined AE with RE, which was suggested in a meta-analysis to present better improvements than either type of exercise alone [3], and expanded the clinical assessment to include trait anxiety and sleep quality as well as measures of aerobic and muscular fitness and found promising results for both clinical and fitness outcomes. This is the first report in the literature on the use of this exercise prescription approach (self-selected intensity) with combined AE and RE training in patients with depression. Despite the constraints of a case study, this report may serve as a basis for future interventions using exercise for patients with depression and other mental health problems. It is noteworthy that despite the results by Callaghan *et al.* [20] published more than 10 years ago only a handful of studies have used a self-selected intensity exercise prescription approach in patients with depression, which seems to be ignoring the impact of imposed exercise intensity on psychological outcomes and, likely, adherence. Future studies with exercise for depression either as a standalone or adjunct therapy should consider including a model of self-selected/preferred exercise intensity, with AE and RE in isolation and combined to assess the effects of this exercise prescription approach. It should be noted that all previous studies were of limited duration (12–24 sessions in 4–8 weeks). Thus, long-term effects on clinical parameters, fitness, and adherence remain to be addressed.

Adherence to the training program was relatively low at 64.3%, with the patient attending 27 out of 42 available sessions. Exercise adherence presents a significant challenge across various populations. Research indicates that approximately 60% of healthy individuals discontinue exercise within the first 3 months, with 70–80% abandoning it after 6 months, and fewer than 15% maintaining the behavior for more than 12 months [4, 5]. In individuals with depression, a meta-analysis revealed that 67% do not meet the recommended levels of physical activity when assessed via self-reported measures, and 85% do not meet these levels when assessed using objective measures [7]. Furthermore, low compliance rates are consistent findings in this case report. A systematic review found exercise compliance among individuals with depression to vary between 50% and 100% [3]. In the study by Callaghan *et al.* [20], exercise compliance was reported at 66% for the preferred intensity group ($n=11$) and 50% for the prescribed exercise intensity group ($n=10$). In addition, a study by Doose *et al.* [19] with 46 individuals experiencing mild-to-severe depression reported an exercise compliance rate of 58%. Given the alarmingly low levels of physical activity and exercise adherence among patients with mild-to-severe depression, interventions designed to enhance exercise adherence and promote physically active behavior are essential. Observations from both the trainer and the patient's self-reports indicate that absences were most common on the days of, and the days following, psychotherapy sessions. The patient also suggested that adherence might have been further reduced if the training model had not been self-selected. From a practical standpoint, employing a self-selected exercise intensity approach and scheduling

training sessions before therapy or at least 2 days afterward may contribute to improved adherence.

Regarding the patient's self-selected intensity, it can be argued that while aerobic exercise was performed at a moderate intensity, the resistance training was conducted at a light intensity, which may limit strength gains and overall effectiveness. Several points merit emphasis in this context. First, individuals with depression often face greater challenges in engaging in regular physical activity compared with those without psychiatric conditions [7]. Therefore, it is crucial to prioritize the engagement and retention of individuals with depression in exercise programs [6]. Aiming to maximize fitness gains might subject them to levels of discomfort during and after exercise, such as delayed onset muscle soreness, which could hinder their motivation and reduce adherence to exercise routines. Second, for physically inactive or sedentary individuals initiating a resistance training program, it is essential to set exercise intensity at lower levels to facilitate adaptation to the new routine, gradually progressing toward higher intensities [22]. A prescribed exercise model for sedentary individuals or beginners would typically involve starting with 30–50% of their maximum strength during the initial weeks of training [22, 23]. It is important to recognize that intensities below recommended levels can still lead to improvements in muscle strength and size [22, 23]. For instance, a recent randomized controlled trial demonstrated that older women increased muscle strength and size after a 12-week resistance training program utilizing self-selected RE intensity, which averaged around 40% of their maximum strength [24]. Furthermore, the patient in this study achieved a 13% increase in strength and approximately 8% in aerobic fitness. It is crucial to reiterate that the objective of a self-selected intensity prescription model is to enhance adherence rather than maximize fitness gains, especially in light of the shortcomings of traditional imposed-based exercise prescriptions to elevate physical activity levels and encourage sustained exercise adherence. The self-selected intensity approach is not intended to replace conventional exercise prescriptions; instead, it serves as an alternative strategy to promote engagement in physical activity.

It is important to highlight that, despite its promising findings, the present study has significant limitations. The foremost limitation is its study design; as a single case study involving a female participant, the results cannot be generalized to a larger population or to male individuals. Consequently, randomized controlled trials with larger sample sizes are necessary to validate these findings. Second, the absence of a control group prevents the disentangling of effects attributable solely to the exercise intervention versus those resulting from other factors, such as the social interaction with the trainer. Third, the study implemented a relatively short-term intervention of only 8 weeks. Given the chronic nature of depression, longer-duration interventions may yield more substantial results. Fourth, the low compliance rate observed could compromise the findings, suggesting that incorporating replacement sessions may be beneficial for increasing compliance and the overall "dose" of exercise. Finally, outcome measures were evaluated only 2 weeks after the intervention, and no follow-up assessments were conducted to determine whether the observed effects could be sustained over time.

Conclusion

Combined exercise with self-selected intensity seems to be a promising tool for improving clinical and fitness parameters in patients with MADD. In summary, while this case report offers valuable preliminary insights, further research featuring larger samples, control groups, robust study designs, extended intervention durations, and comprehensive follow-up assessments is essential to substantiate these findings.

Patient's feedback from the intervention

"Participating in this intervention was a very special experience that added a lot to various aspects of my life. Initially, I was a bit unsure, feeling that it might be too much of a commitment for me at that moment. This was because I hadn't felt interest or motivation to engage in almost any activity. However, the medical recommendation, the opportunity to have a personal trainer-like experience, and the trust I have in the instructor were the factors that motivated me to accept. And the reasons that kept me going until the end went far beyond that."

"I've always been an active person who loves to exercise. But even that became very difficult after I began my treatment. Although I couldn't act on it, I missed it and knew the great benefits I could gain. But when you're in a depressive state, the gap between knowing and doing becomes immense. In this regard, I immediately felt that the format of the intervention helped a lot. The ability to self-select exercises brought me immense satisfaction in doing them. I think it's important to note that, initially, this satisfaction was directly related to the fact that I didn't feel pressured by what I would likely see as strict goals, nor tense about possibly failing to meet them. I realized that I started to associate training sessions as one of the few moments when I could be free from social pressures."

"On the days I felt more energetic and emotionally balanced, I would challenge myself by selecting more intense workouts because I knew I wouldn't put myself

in an uncomfortable situation. I also had the need to once again feel the great well-being that more intense physical exercise had always given me. At the same time, there were days when I wasn't doing as well, and I selected minimal loads, mainly to avoid feelings of frustration or losing interest in training. On those tougher days, I noticed that simply being able to leave the house and make it to training gave me a sense of accomplishment, making me feel like I was progressing. There were also (and many) days when I simply couldn't train. These were usually therapy days or the days following them, as I needed a lot of time to process the physical and emotional strain from the sessions. Some absences were also due to the side effects of the medication I take. But knowing and feeling that the professional who accompanied me would understand, and that her goal was to support my overall recovery, made me feel much more at ease and relieved to return to training without feeling ashamed or like a failure for missing so many sessions. On the contrary, at many points, I felt motivated to make up for the missed sessions, leading me to train with more intensity and enthusiasm."

"The only area where self-selection wasn't fully able to overcome my difficulties was with aerobic exercise. Running has never been my favorite activity, and on days when I wasn't feeling up to it, spending 25 min on the treadmill, regardless of the speed I chose, was very challenging. I also thought that the order (whether it was at the beginning or end of the session) would significantly affect my performance. But by the end of the intervention, I realized that it wasn't just about whether or not the exercise would be done or when it would be done. I also saw a very positive aspect related to aerobic exercise itself. I understood its importance within the workout structure and believe that choosing the style that suits me best will be essential for improving my adherence to future workouts."

"Another aspect I believe the exercise routine has specifically contributed to is the frequency and intensity of emotional crises, when symptoms become much more intense. Before the intervention, I had crises much more frequently and for longer durations (sometimes two or three times a month, and it took days for me to recover). I also used anxiolytics (Rivotril) to induce a sense of calm during crises. In the last month, I had only one crisis, which didn't even reach its peak, as I was able to calm myself down (I didn't feel the need for the anxiolytic) in a much shorter time. According to my psychiatrist, this suggests that we might be able to taper off the medication faster than we had anticipated."

Regarding socialization, this was another area that was greatly affected for me. I naturally tend to be more reserved, but due to the illness, I began actively avoiding contact with others. In my case, living alone, this created a significant gap in my treatment. Therefore, the daily and healthy contact, especially with the instructor, was very important in helping me disconnect from feelings of loneliness and encouraging my socialization."

"I believe that one other important lesson I'm taking away from this intervention is understanding why I should adopt physical exercise as a lifelong practice, as an essential tool for preventing and maintaining good health. What always motivated me to exercise was the fact that I genuinely enjoy it and also have a more competitive spirit, especially in team activities. But through my experience with depression and this intervention, I've come to understand why making exercise a permanent part of my life is crucial. The psychological symptoms of depression have significantly impacted me physically, but I believe the opposite can also work very positively. In dealing with this illness, I've had to reassess and adjust my habits and values, and health has become the most important of them. Therefore, I intend to use my existing love for exercise, along with the great experience, sensations, and knowledge (especially about my limits and optimal stimuli) gained from this intervention, to truly adopt physical activity as a lifestyle."

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13256-025-05622-3.

Additional file1

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Conceptualization: DSAC, HF, EA, and DGDM; methodology: DSAC, HF, EA, and DGDM; investigation: DSAC, HF, and DGDM; data curation: DSAC, HF, EA, and DGDM; formal Analysis: DGDM; visualization: DGDM; writing—original draft: DGDM; writing—review and editing: DSAC, HF, EA, and DGDM.

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Availability of data and materials
The data generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
Written informed consent was obtained from the patient for publication of this case report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

Competing interests
The authors declare that they have no competing interests.

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