Journal of Exercise Science & Fitness 23 (2025) 246–251

Contents lists available at ScienceDirect

Journal of Exercise Science & Fitness

journal homepage: www.elsevier.com/locate/jesf

Feasibility and effects of high-intensity interval training in older adults with mild to moderate depressive symptoms: A pilot cluster-randomized controlled trial

Yanping Duan [a,*,e,f], Yanping Wang [a,e], Wei Liang [b,**,f], Heung-Sang Wong [c], Julien Steven Baker [a], Shuyan Yang [d]

[a] Department of Sports and Health Sciences, Hong Kong Baptist University, Hong Kong, China
[b] School of Physical Education, Shenzhen University, Shenzhen, China
[c] Department of Sports Science and Physical Education, The Chinese University of Hong Kong, Hong Kong, China
[d] Department of Innovative Social Work, City University of Macau, Macao Special Administrative Region of China

ARTICLE INFO

Keywords:
High-intensity interval training
Baduanjin qigong
Feasibility
Depressive symptoms
Physical fitness

ABSTRACT

Background: Older adults with mild-to-moderate depressive symptoms (MMDS) are at high risk of developing severe depression along with mortality and disability. The aim of this study was to investigate the feasibility and preliminary effects of high-intensity interval training (HIIT) in older adults with MMDS in a small sample size.
Methods: Three elderly centers involving 24 older adults with MMDS were randomized into: 1) HIIT (n = 8); 2) moderate-intensity continuous training (Baduanjin Qigong) (MICT-BDJ) (n = 8); or 3) recreation workshop (RW) control (n = 8) for 16-week (32 session) intervention. Feasibility was assessed using retention rate, session attendance rate, exercise intensity adherence, acceptability, and safety. Depressive symptoms were assessed using the Chinese version of the 15-item Geriatric Depression Scale, while physical fitness (PF) was measured using the Senior Fitness Test. Depressive symptoms and PF were evaluated at baseline and post-intervention.
Results: 20 participants completed data collection twice. The retention rate was 87.5 % (7/8), 87.5 % (7/8), 75 % (6/8) for HIIT, MICT-BDJ, and RW, respectively. 87.5 % (7/8) of HIIT participants completed at least 75 % of exercise sessions. 81.4 % of HIIT participants achieved pre-designed intensity (≥80 % maximum heart rate) during high-intensity intervals. All HIIT (7/7) participants were satisfied with their group allocation. More HIIT (6/7) than MICT-BDJ (5/7) participants found exercise enjoyable. Two mild adverse events were reported in HIIT group. HIIT improved depressive symptoms more than MICT-BDJ (d = -1.02) and RW (d = -1.32). Both HIIT (d = 1.26) and MICT-BDJ (d = 1.39) improved PF more than RW.
Conclusions: This study provides preliminary evidence on the feasibility and effect of HIIT for older adults with MMD. Both HIIT and MICT-BDJ improved depressive symptoms and PF. HIIT demonstrated better efficacy in depressive symptoms and mobility than MICT-BDJ. The findings should be interpreted cautiously due to several limitations. The rigorous cluster randomized controlled trial with large-scale sample size is warranted in the future to affirm the current findings.
Trial registration: Trial Registration: NCT06014294.

1. Introduction

Depression is a common mental health problem among older adults, which is associated with physical impairment, psychiatric comorbidities and an elevated risk of morbidity and mortality.[1] Compared to people with mild and moderate depression, those with severe depression may develop psychotic symptoms (e.g., delusions) and have higher mortality and disability.[2] Effective treatment for mild and moderate depressive

* Corresponding author.
** Corresponding author.
E-mail addresses: duanyp@hkbu.edu.hk (Y. Duan), wliang1020@szu.edu.cn (W. Liang).
[e] Co-first authors: these authors contributed equally to this work and share first authorship.
[f] Co-correspondence: these authors contributed equally to this work and share corresponding authorship.

https://doi.org/10.1016/j.jesf.2025.05.004
Received 10 October 2024; Received in revised form 21 May 2025; Accepted 21 May 2025
Available online 24 May 2025

symptoms can prevent the deterioration of depressive pathology to severe and psychotic symptoms, and this is particularly important for older adults.

Considerable evidence has demonstrated that regular physical exercise is associated with a lower prevalence of late-life depression.[3] Traditional moderate-intensity continuous training (MICT) (e.g., Baduanjin Qigong) has historically been the compelling exercise recommendation in the improvement of depression and physical fitness among older adults.[4,5] However, older adults with mental illness have poor engagement and compliance with MICT programs.[6] In recent years, as a novel type of exercise, high-intensity interval training (HIIT), which includes repeated bouts of high-intensity exercise interspersed with periods of rest, appears to be a promising approach to overcoming limitations in traditional MICT programs.[6,7]

Previous evidence has indicated that HIIT interventions demonstrated superior performance outcomes in improving brain-derived growth neurotrophins, dopamine, and other chemicals compared to MICT, suggesting biological advantages of HIIT interventions for depression prevention and treatment compared to MICT.[8–10] Moreover, HIIT is a superior way to increase physical fitness (e.g., aerobic capacity, muscular strength) compared to MICT, as the high-intensity nature of exercise induces greater central and peripheral adaptations of the oxidative pathway, leading to improved cardiorespiratory function, as well as places greater demands on the muscles, leading to increased muscles fiber recruitment and adaptations.[11]

Recently three review studies have shown that HIIT demonstrates similar or greater effects on mental health and physical fitness among older adults than MICT, with more time efficiency, more enjoyment, and higher compliance.[11–13] However, all HIIT studies in the reviews focused on healthy older adults and elderly with cardiovascular disease, heart disease, type-2 diabetes, or Alzheimer's disease. No study targeted older adults with depressive symptoms. Considering there is little empirical evidence of HIIT benefits related to older adults with depressive symptoms, this pilot study aimed to evaluate the feasibility and effects of a HIIT intervention in Hong Kong Chinese older adults with mild to moderate depressive symptoms in a small sample size.

2. Methods

This study comprised a single-blinded (data assessors), three-group, 16-week cluster-randomized controlled trial (C-RCT) with baseline and post-intervention outcome measures (March 2023 to July 2023). The study protocol was approved by the Research Ethics Committee of Hong Kong Baptist University (REC/21–22/0169) and was registered on the Clinical Trial Registry (NCT06014294). To decrease the risk of performance and detection biases, participants and exercise instructors in this study were masked about the group types and allocations.

Three eligible elderly centers were purposively selected from the three major districts of Hong Kong (Hong Kong Island, Kowloon, New Territories), respectively. Eligible elderly centers fulfilled the criterion that there were no ongoing projects related to physical exercise promotion that might contaminate the effects of this study. Then eligible centers were randomized into three groups: HIIT, MICT-Baduanjin Qigong (MICT-BDJ) exercise, or non-exercise control (recreation workshop). Randomization was undertaken using the random function in Excel, with a ratio of 1:1:1, by a research team member who was not involved in the intervention implementation, data collection, and outcome evaluation.

According to the sample size applied to the existing HIIT pilot studies among older adults,[14,15] a minimum of 6 participants in one group within total of at least 18 participants from three groups was required to ensure adequate information for assessing feasibility and effectiveness. Considering an attrition rate of around 25 %[15] and around 30 % prevalence of depression symptoms among Hong Kong older adults,[16] approximately 27 participants in one group (centre) with in total at least 81 participants for three groups (centers) should be contacted at the initial recruitment stage. The flow of eligible participants through the study is shown in the CONSORT diagram outlined in Appendix 1.

All older adults in the recruited elderly centers were invited to participate in the study, where eligible participants met the inclusion criteria: 1) aged 60–74; 2) have mild or moderate depressive symptoms (i.e., scoring 5–11 in the Chinese version of Geriatric Depression Scale, GDS-C)[17]; 3) pass the Physical Activity Readiness Questionnaire plus (PAR-Q+) screening or with the physician's approval for the readiness of participation in the high-intensity exercise; 4) no restriction on physical mobility; 5) no cognitive impairment (i.e., scoring <24 in the Chinese version of the Mini-Mental Status Examination. MMSE-C)[18]; and 6) no previous profound experiences with practicing HIIT or Baduanjin Qigong. All participants completed the written informed consent form before the study commenced.

Based on previous literature, the duration of effective HIIT programs on improving mental and physical health among older adults generally ranges from 4 to 16 weeks with at least 2 sessions per week.[13,19] Considering that older adults with depressive symptoms may need more time to obtain benefits from exercise therapies as well as the feasibility of program implementation in older adults, an intervention period of 16 weeks with 2 sessions per week was adopted in this study. Each exercise session comprised three sections: warm-up, main exercise, and cool-down. Exercise intensity of HIIT was monitored using heart rate monitors (Polar-Verity-Sense) and the self-reported Rate of Perceived Exertion (RPE) (Borg Category Ratio-10 Scale) while the intensity of MICE-BDJ was monitored only using RPE13.[17] The total HIIT section progressed from 14 min in Weeks 1–2 to 19 min 50s in Weeks 15–16. Each HIIT section consisted of ten distinct movements (cardiorespiratory exercise + resistance training). For MICT-BDJ group, the 10-posture Baduanjin Qigong[20] was delivered. The content for two exercise groups is outlined in Appendix 2, Table S1–S2. To control the confounders (e.g., group dynamics, social interaction, expectancy effects), the non-exercise control group received a series of group-based and instructor-led workshops related to daily recreation that were identical in all respects to the HIIT and MICT-BDJ groups (e.g., frequency and duration of intervention, no interaction among participants during the intervention) (see Appendix 2, Table S3).

For outcome measures, feasibility was assessed using five indicators, including retention rate, session attendance rate, exercise intensity adherence, acceptability of the exercise condition, and exercise safety. The criterion for each feasibility indicator is outlined in Table 1. Depressive symptoms and physical fitness were assessed using the 15-item GDS-C (Cronbach's $\alpha = 0.83$),[21] and the Senior Fitness Test (SFT) battery,[22] respectively.

Data analyses were conducted using SPSS 28.0. Mean, standard deviation, frequency, and percentage were used to present the descriptive information of participants and outcome measures. Independent *t*-test and Chi-square Pearson test were employed for evaluating the differences in exercise intensity (RPE) and acceptability items. Generalized linear mixed models were applied to evaluate the intervention effects on depressive symptoms and physical fitness.

3. Results

Table 1 shows the baseline characteristics of participants and the results of feasibility analyses. The total retention rate was 83.3 %, with 87.5 %, 87.5 % and 75 % for HIIT, MICT-BDJ, and RW, respectively. For session attendance, only participants who attend at least one intervention session were included in the analysis (HIIT = 8, MICT-BDJ = 8, RW = 7). The total session attendance rate was 88.3 % ± 0.082, with 86.6 % ± 0.059, 88 % ± 0.109, 90.6 % ± 0.077 for HIIT, MICT-BDJ, and RW, respectively. 87.5 % (7/8) of the HIIT participants, 75 % (6/8) of the MICT-BDJ participants, and 85.7 % (6/7) of the workshop participants completed at least 75 % of intervention sessions (24/32 sessions).

For exercise intensity adherence, the average HR of HIIT group increased from 120 bpm to 128 bpm through the progression of training,

Table 1
Baseline characteristics of the study sample and results of feasibility analyses.

	Total (n = 20)	HIIT (n = 7)	MICT-BDJ (n = 7)	RW (n = 6)
Baseline characteristics				
Age, years, mean (SD)	69.9 (3.5)	70.1 (3.5)	68.3 (4.4)	71 (1.8)
Female, n (%)	18 (90 %)	5 (71.4 %)	7 (100 %)	6 (100 %)
Marital status, n (%)				
Single	5 (25 %)	1 (14.3 %)	2 (28.6 %)	0 (0 %)
Married	11 (55 %)	4 (57.1 %)	4 (57.1 %)	5 (83.3 %)
Divorced/widowed	4 (20 %)	2 (28.6 %)	1 (14.3 %)	1 (16.7 %)
Education level, n (%)				
Primary or below	5 (25 %)	2 (28.6 %)	0 (0 %)	3 (50 %)
Middle or high school	12 (60 %)	3 (42.8 %)	6 (85.7 %)	3 (50 %)
College or above	3 (15 %)	2 (28.6 %)	1 (14.3 %)	0 (0 %)
Occupational status				
Employed	1 (5 %)	1 (14.3 %)	0 (0 %)	0 (0 %)
Unemployed/Retired	19 (95 %)	6 (85.7 %)	7 (100 %)	6 (100 %)
Household income, n (%)				
<HK$20,000/month	18 (90 %)	7 (100 %)	5 (71.4 %)	6 (100 %)
≥HK$20,000/month	2 (10 %)	0 (0 %)	2 (28.6 %)	0 (0 %)
BMI, kg/m[b], mean (SD)	23.1 (2.7)	23.9 (2.5)	21 (2.4)	24.7 (1.5)
Feasibility analyses[a]				
Retention rate[b]	20/24 (83.3 %)	7/8 (87.5 %)	7/8 (87.5 %)	6/8 (75 %)
Session attendance rate[c]				
Mean values of attendance rate	88.3 % ± 0.082	86.6 % ± 0.059	88 % ± 0.109	90.6 % ± 0.077
% of participants achieved the criteria	19/23 (82.6 %)	7/8 (87.5 %)	6/8 (75 %)	6/7 (85.7 %)
Exercise intensity adherence[d]				
% of participants achieved the high-intensity (≥80 % HRmax at workout)	Not applicable	81.4 %	Not applicable	Not applicable
Average RPE during the workouts	5.21 ± 2.53	7.66 ± 0.82	2.83 ± 0.47	Not applicable
Exercise safety[e]	2 mild adverse events	2 mild adverse events	0 adverse event	0 adverse event

Note. HIIT = high-intensity interval training; MICT-BDJ = moderate-intensity continuous training-Baduanjin; RW = recreation workshop; SD = standard deviation; BMI = body mass index; HR = heart rate; RPE = rate of perceived exertion.

[a] Five indicators are involved in the feasibility analyses, including retention rate, session attendance rate, exercise intensity adherence, acceptability, and exercise safety. The result of acceptability is outlined in Appendix 2, Table S4 due to the limited space here.

[b] Criterion: more than 70 % of participants completed data collection.

[c] Criterion: at least 2/3 (66.7 %) of participants completed at least 75 % of intervention sessions (24/32 sessions).

[d] Criterion: at least 80 % of participant's average %HR max during the high-intensity intervals reached ≥80 %HR max in the HIIT group; and the overall RPEs of HIIT and MICT-BDJ cross all exercise sessions fall into 5–8 points and 2–3 points respectively referring to the exercise protocol.

[e] Criterion: no severe adverse events were reported during the 16-week exercise sessions.

and the average peak HR ranged from 140 bpm to 151 bpm. The average %HRmax was 78.4 % ± 0.01 % (range: 75–81 %) during the HIIT section, including workout and recovery. 81.4 % of participants' average % HRmax reached ≥80 %HRmax during the high-intensity intervals (range: 66.67 %–100 %), while 18.6 % of participants performed below target intensity in some sessions (see Appendix 3, Fig. S1). In addition, both HIIT and MICT-BDJ reported overall RPE at the end of each session to show intensity adherence. Participants in the HIIT group exercising at higher intensities ($Mean_{RPE} = 7.66 \pm 0.82$; range: 6.14–9) compared to those in the MICT-BDJ group ($Mean_{RPE} = 2.83 \pm 0.47$; range: 2–3.67) (see Appendix 3, Fig. S2). A significantly higher RPE ($t_{62} = 28.96$, $p < 0.001$) was reported in HIIT group compared to MICT-BDJ group across all exercise sessions.

For acceptability, although Chi-square tests did not show any significant differences between two exercise groups ($p > 0.1$), HIIT group showed descriptively superior feedback on the satisfaction (100 % vs 71.4 %), enjoyment (85.7 % vs 71.4 %), and expectation of the exercise (100 % vs 85.7 %) compared to the MICT-BDJ group (see Appendix 2, Table S4). For exercise safety, two mild study-related adverse events (knee soreness, low back pain) were documented in the HIIT group. One participant reporting lower back pain was advised to skip two sessions. After the break, she reported her unwell condition had resolved and resumed the training. Another case reported knee pain when performing exercise and claimed that she had a history of knee problems. When the condition re-occurred in the next session, the participant dropped out from the HIIT group since session five. No adverse events were reported in the MICT-BDJ group.

For the intervention efficacy, significant time × group interaction effects were found on both depressive symptoms ($F_{17,2} = 3.7$, $p = 0.046$) and total physical fitness z-score ($F_{17,2} = 4.5$, $p = 0.026$) (Table 2). HIIT group prominently alleviated their depressive symptoms with a large effect size compared to MICT-BDJ ($d = -1.02$) and RW ($d = -1.32$). Both HIIT and MICT-BDJ showed favorable improvements in total physical fitness compared to RW with large effect sizes ($d = 1.26$–1.39).

4. Discussion

This pilot C-RCT study, to the best of our knowledge, provides results on the feasibility and effects of high-intensity interval training in older adults with mild or moderate depressive symptoms for the first time to our knowledge. We found that the HIIT was well tolerated, with retention rates and session attendance rates that were superior to or comparable to MICT-BDJ and the recreation workshop. The HIIT group achieved the pre-defined exercise intensity adherence rate with mild adverse events. All HIIT participants were satisfied with the exercise and most of them found the exercise enjoyable. Additionally, the HIIT group showed a superior improvement in depressive symptoms compared to MICT-BDJ and recreation workshop groups. Both exercise groups indicated a favorable enhancement in physical fitness compared to the recreation workshop group.

It is notable that the study retention of two exercise groups (87.5 %) were higher than the recreation workshop group (75 %), which is also higher than reported in previous exercise training programs among adults with mental illness (82 %).[23] 87.5 % of the HIIT participants and 75 % of the MICT-BDJ participants completed at least 75 % of exercise sessions in this study, which was satisfactory and higher than those reported in previous HIIT studies with older adults with various medical conditions (e.g., major depression, breast cancer, HIV).[23,24]

Compared to previous HIIT programs that recommended a 1:1 or 1:2 ratio for high-intensity workload and recovery,[24] this study implemented a progressively increasing setting that ranged from a 1:2 ratio (with 30s of exertion and 60s of active recovery for Week 1–2) to an approximately 1:1 ratio (with 65s of exertion and 60s of active recovery for Week 15–16). 81.4 % of participants in the HIIT group were able to achieve the pre-defined exercise intensity as monitored by objective measurements, thereby supporting the feasibility of the progressive HIIT protocol employed in this study. For safety issues, one adverse event led to a dropout in this study. It implied that although participants passed the PARQ + screening and were free from physical mobility restriction, their unwell physical condition history (e.g., knee pain) should be reported and considered during the screening. Excluding such cases before the intervention may prevent sports injury and dropout from the HIIT program.

Table 2
Outcome data for depressive symptoms and physical fitness.

Outcome measures	HIIT		MICT-BDJ		RW		Intervention effect			HIIT vs RW	HIIT vs MICT-BDJ	MICT-BDJ vs RW
	Pre	Post	Pre	Post	Pre	Post	Time	Group	Time x group	*d*	*d*	*d*
Depressive symptoms	6.4 (1.9)	3.3 (2.1)	6.9 (3.1)	5.7 (3.8)	6.8 (1.7)	6 (2.1)	$F_{17,1}$ = 20.3, P < 0.001	$F_{17,2}$ = 0.8, P = 0.45	$F_{17,2}$ = 3.7 P = 0.046	**−1.32**	**−1.02**	−0.24
Total PT z-score	0.2 (0.3)	0.3 (0.3)	−0.3 (0.4)	−0.1 (0.3)	0.1 (0.2)	−0.3 (0.4)	$F_{17,1}$ = 0.2, P = 0.63	$F_{17,2}$ = 4.4, P = 0.03	$F_{17,2}$ = 4.5 P = 0.026	**1.26**	−0.27	**1.39**
BMI (kg/m^2)	23.9 (2.5)	23.5 (2.3)	21 (2.4)	20.7 (2.1)	24.7 (1.5)	24.7 (1.5)	$F_{17,1}$ = 3.4, P = 0.08	$F_{17,2}$ = 5.7 P = 0.012	$F_{17,2}$ = 1.8 P = 0.19	**−0.97**	−0.03	**−1.01**
30s chair stand	21.9 (6.5)	23.1 (6.8)	14.9 (9)	17.3 (5.3)	10.8 (5.5)	12.5 (6)	$F_{17,1}$ = 4.8, P = 0.043	$F_{17,2}$ = 4.7 P = 0.023	$F_{17,2}$ = 0.2 P = 0.84	−0.15	−0.27	0.19
30s arm curl	21.7 (7.1)	24.4 (5.1)	14.3 (5.8)	16.7 (4.9)	14 (4.2)	13 (4.9)	$F_{17,1}$ = 2.1, P = 0.17	$F_{17,2}$ = 6.8 P = 0.007	$F_{17,2}$ = 1.5 P = 0.26	**1.01**	0.07	**0.73**
2min step	83.1 (17.8)	103.6 (9.6)	71 (19.8)	94.1 (22.9)	55.8 (35.9)	63 (34.1)	$F_{17,1}$ = 6.8, P = 0.018	$F_{17,2}$ = 5 P = 0.02	$F_{17,2}$ = 0.5 P = 0.59	0.46	−0.1	0.49
Chair sit-and-reach	6.9 (11.6)	10 (9.6)	13.6 (8.6)	13.9 (13.9)	11.6 (7.2)	−0.1 (9.2)	$F_{17,1}$ = 1.4, P = 0.25	$F_{17,2}$ = 1.4 P = 0.29	$F_{17,2}$ = 3.7 P = 0.048	**1.3**	0.38	**1.01**
Back scratch	5.1 (7.6)	5.4 (5)	6 (2.4)	6.9 (4.5)	11.4 (5.5)	−0.8 (8.8)	$F_{17,1}$ = 4.1, P = 0.06	$F_{17,2}$ = 0.2 P = 0.84	$F_{17,2}$ = 5.3 P = 0.016	**1.29**	−0.12	**1.53**
8 ft up-and-go	5.8 (1.1)	5.3 (0.6)	5 (1.1)	5.4 (1)	6.6 (1)	6.7 (1.1)	$F_{17,1}$ = 0.1, P = 0.94	$F_{17,2}$ = 4.5 P = 0.027	$F_{17,2}$ = 2, P = 0.16	**−0.84**	**−1.17**	0.16

Note. Pre and post are mean (SD); d = standardized change score expressed as Cohen's d.
Abbreviations: HIIT = high-intensity interval training; MICT-BDJ = moderate-intensity continuous training-Baduanjin; RW = recreation workshop; PT = physical fitness.
Bold values signify moderate or large effect sizes.

Previous lab-based HIIT programs commonly employed machines (e.g., cycle ergometer, treadmill) due to the ease of monitoring exercise intensity.[25] However, implementing this type of exercise in a real-world context that targets a larger sample size of populations can be challenging.[26] Additionally, exercises performed using machines are limited in their ability to fully develop the essential skills of balance, gait and coordination that are vital to the daily lives of older adults.[27] In addition, for older adults with mental illness, group-based exercise has been extensively recommended in previous studies.[28] Therefore, the exercise protocol employed in this study is tailored to meet the needs of older adults with mild or moderate depressive symptoms in a real-world setting, incorporating a group-based, machine-free exercise format, supervised multifaceted exercise movements, ample social support, and musical accompaniment. Overall, this pilot study provided evidence supporting the satisfaction, enjoyment, and safety of the HIIT program.

In terms of the intervention effects, this study revealed the superiority of the HIIT on alleviating depressive symptoms in older adults with mild to moderate depression compared to MICT-BDJ and recreation workshop control groups, which is in line with Dunn et al.'s study finding targeting adults diagnosed with mild to moderate major depressive disorder.[29] It implies that HIIT can be an alternative exercise regimen for improving depressive symptoms among elderly participants. This study also showed the comparable effects of HIIT and MICT-BDJ on physical fitness, which supports previous empirical studies and meta-analyses in older adults who were healthy and sedentary, or people with heart disease and type-2 diabetes.[13,30] The findings inform the noticeable clinical value of HIIT for improving mental and physical health in older people. This will enable scale-up to a larger project to advance the health promotion of this emerging exercise in community-dwelling older adults with MMD.

Several limitations should be noted. Firstly, only three elderly centers were randomized in this study with one centre for one study group. This may weaken the validity of the randomization and limit the diversity of the sample. In addition, the sample size in this pilot study (n = 20) is small, which shows similar limitations as other previous HIIT pilot studies.[14,15] Such methodological shortcomings may undermine the statistical power and generalizability of the findings. Therefore, caution is warranted when interpreting the results. A rigorous C-RCT study with a full-scale sample size is required to affirm HIIT efficacy on depressive symptoms in the future. Secondly, the narrow demographic profile of the participants (90 % female participants and aged 60–74 years) limited the generalization of findings. Future trials should balance the gender distribution of elderly participants. Notably, the current HIIT protocol is only applicable to young older adults. More simple- and easy-operating HIIT modalities, such as HIIT walking can be explored and applied to the broader age range of the elderly population in the

future. Thirdly, the exercise intensity of MICT-BDJ was monitored using self-reported RPE, which may produce recall bias. Future studies should include objective measures (e.g., heart rate monitors) in the MICT-BDJ group and report the exercise intensity adherence with %HRmax achieved in this group. Fourthly, depressive symptoms were assessed using a self-reported scale. While the scale has been extensively validated in previous studies among older adults in Hong Kong, the measure biases (e.g., recall bias, social desirability bias) cannot be eliminated. Biomarkers of depressive symptoms should be added to future studies, such as depression-related neurotransmitters, hormones, inflammatory markers, and brain-derived neurotrophic factors, to validate the efficacy of intervention. Finally, the study only focused on the immediate effects of HIIT intervention but did not address its sustainable impact. Three to six months follow-up evaluation should be warranted to affirm the long-term antidepressant efficacy of HIIT in the future. Additionally, the underlying biological and psychological mechanisms of HIIT that contribute to the successful reduction of depressive symptoms are worth exploring further.

5. Conclusions

In summary, this pilot study provides preliminary evidence for the feasibility of the HIIT program and its efficacy in ameliorating depressive symptoms and enhancing physical fitness in community-dwelling older adults with mild to moderate depression. Still, the findings should be interpreted cautiously due to several limitations. The rigorous C-RCT with large-scale sample size is warranted to affirm efficacy and enable evidence-based exercise recommendations for this population in the future.

Author statement

Conceptualization, Y.D., W.L., and Y.W.; methodology, Y.D., W.L., Y. W., H.W. S.Y. and J.S.B.; validation, Y.D., W.L. and Y.W.; formal analysis, W.L. and Y.W.; investigation, Y.D. and Y.W.; resources, Y.D; data curation, W.Y. and W.L.; writing—original draft, Y.D., W.L. and W.Y.; writing—review and editing, Y.W., H.W., S.Y. and J.S.B.; supervision, Y. D.; project administration, Y.D.; funding acquisition, Y.D. All authors have read and agreed to the published version of the manuscript.

Data availability statement

The data sets generated during the present study are not publicly available, owing to the risk of disclosure or deduction of private individual information, but they are available from the corresponding author on reasonable request.

Ethic statement and consent to participate

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The ethics approval was obtained from the Research Ethics Committee of Hong Kong Baptist University (REE.21022/0169). All the participants completed the written informed consent form prior to the study's commencement.

Funding

This research was funded by the General Research Fund, University Grants Committee, Hong Kong Special Administrative Region (Ref. No. 12616922; 2022/23).

Declaration of competing interest

All authors declared no conflict of interest.

Acknowledgments

We would like to express our gratitude to the Research Grants Council of Hong Kong who provided us the financial support as well as to the elderly community centers who provided generous assistance in participant recruitment and data collection.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jesf.2025.05.004.

References

1. Wei J, Hou R, Zhang X, et al. The association of late-life depression with all-cause and cardiovascular mortality among community-dwelling older adults: systematic review and meta-analysis. *Br J Psychiatry*. 2019;215(2):449–455. https://doi.org/10.1192/bjp.2019.74.
2. NCD. Depression: beyond feeling blue. https://www.chp.gov.hk/files/pdf/ncd_watch_sep2012.pdf; 2012.
3. Catalan-Matamoros D, Gomez-Conesa A, Stubbs B, et al. Exercise improves depressive symptoms in older adults: an umbrella review of systematic reviews and meta-analyses. *Psychiatry Res*. 2016;244:202–209. https://doi.org/10.1016/j.psychres.2016.07.028.
4. Chang P-S, Knobf T, Oh B, et al. Physical and psychological health outcomes of qigong exercise in older adults: a systematic review and meta-analysis. *Am J Chin Med*. 2019;47(2):301–322. https://doi.org/10.1142/S0192415X19500149.
5. Zou L, Sasaki JE, Wang H, et al. A systematic review and meta-analysis of baduanjin qigong for health benefits: randomized controlled trials. *Evid Based Complement Altern Med*. 2017;2017. https://doi.org/10.1155/2017/4548706.
6. ACSM. Information on high-intensity interval training. https://www.acsm.org/docs/default-source/files-for-resource-library/high-intensity-interval-training.pdf; 2014.
7. Martland R, Mondelli V, Gaughran F, et al. Can high intensity interval training improve health outcomes among people with mental illness? A systematic review and preliminary meta-analysis of intervention studies across a range of mental illnesses. *J Affect Disord*. 2020;263:629–660. https://doi.org/10.1016/j.jad.2019.11.039.
8. Fiorelli CM, Ciolac EG, Simieli L, et al. Differential acute effect of high-intensity interval or continuous moderate exercise on cognition in individuals with Parkinson's disease. *J Phys Activ Health*. 2019;16(2):157–164. https://doi.org/10.1123/jpah.2018-0189.
9. O'Callaghan A, Harvey M, Houghton D, et al. Comparing the influence of exercise intensity on brain-derived neurotrophic factor serum levels in people with Parkinson's disease: a pilot study. *Aging Clin Exp Res*. 2020;32:1731–1738. https://doi.org/10.1007/s40520-019-01353-w.
10. Korman N, Armour M, Chapman J, et al. High Intensity Interval training (HIIT) for people with severe mental illness: a systematic review & meta-analysis of intervention studies- considering diverse approaches for mental and physical recovery. *Psychiatry Res*. 2020;284, 112601. https://doi.org/10.1016/j.psychres.2019.112601.
11. Liang W, Wang X, Cheng S, et al. Effects of high-intensity interval training on the parameters related to physical fitness and health of older adults: a systematic review and meta-analysis. *Sports Med Open*. 2024;10(1):98. https://doi.org/10.1186/s40798-024-00767-9.
12. Keating CJ, Párraga Montilla J, Latorre Román P, et al. Comparison of high-intensity interval training to moderate-intensity continuous training in older adults: a systematic review. *J Aging Phys Activ*. 2020:1–10. https://doi.org/10.1123/japa.2019-0111.
13. Marriott CFS, Petrella AFM, Marriott ECS, et al. High-intensity interval training in older adults: a scoping review. *Sports Med Open*. 2021;7(1):49. https://doi.org/10.1186/s40798-021-00344-4.
14. Toohey K, Pumpa K, McKune A, et al. The impact of high-intensity interval training exercise on breast cancer survivors: a pilot study to explore fitness, cardiac regulation and biomarkers of the stress systems. *BMC Cancer*. 2020;20(1):787. https://doi.org/10.1186/s12885-020-07295-1.
15. MacDonald G, Sitlinger A, Deal MA, et al. A pilot study of high-intensity interval training in older adults with treatment naïve chronic lymphocytic leukemia. *Sci Rep*. 2021;11(1), 23137. https://doi.org/10.1038/s41598-021-02352-6.
16. Cheung KCK, Chou K-L. Poverty, deprivation, and depressive symptoms among older adults in Hong Kong. *Aging Ment Health*. 2019;23(1):22–29. https://doi.org/10.1080/13607863.2017.1394438.
17. Cheng S-T, Chan A. " A brief version of the geriatric depression scale for the Chinese". *Correction*. 2006. https://doi.org/10.1037/1040-3590.18.1.48.
18. Tse C, Chang J, Leung GT, et al. Effects of education on very mild dementia among Chinese people in Hong Kong: potential mediators in the Cantonese Mini-Mental State Examination tasks. *Aging Ment Health*. 2013;17(3):310–318. https://doi.org/10.1080/13607863.2012.743962.

19. Martland R, Mondelli V, Gaughran F, et al. Can high-intensity interval training improve physical and mental health outcomes? A meta-review of 33 systematic reviews across the lifespan. *J Sports Sci*. 2020;38(4):430–469. https://doi.org/10.1080/02640414.2019.1706829.
20. Zou L, Pan Z, Yeung A, et al. A review study on the beneficial effects of Baduanjin. *J Alternative Compl Med*. 2018;24(4):324–335. https://doi.org/10.1089/acm.2017.0241.
21. Knapen J, Van de Vliet P, Van Coppenolle H, et al. Evaluation of cardio-respiratory fitness and perceived exertion for patients with depressive and anxiety disorders: a study on reliability. *Disabil Rehabil*. 2003;25(23):1312–1315. https://doi.org/10.1080/0963828031000161627 7.
22. Rikli RE, Jones CJ. *Senior Fitness Test Manual*. Human kinetics; 2013.
23. Chapman JJ, Coombes JS, Brown WJ, et al. The feasibility and acceptability of high-intensity interval training for adults with mental illness: a pilot study. *MHPA*. 2017;13:40–48. https://doi.org/10.1016/j.mhpa.2017.09.007.
24. Schulz SVW, Laszlo R, Otto S, et al. Feasibility and effects of a combined adjuvant high-intensity interval/strength training in breast cancer patients: a single-center pilot study. *Disabil Rehabil*. 2018;40(13):1501–1508. https://doi.org/10.1080/09638288.2017.1300688.
25. Pires Peixoto R, Trombert V, Poncet A, et al. Feasibility and safety of high-intensity interval training for the rehabilitation of geriatric inpatients (HIITERGY) a pilot randomized study. *BMC Geriatr*. 2020;20(1):197. https://doi.org/10.1186/s12877-020-01596-7.
26. Gray SR, Ferguson C, Birch K, et al. High-intensity interval training: key data needed to bridge the gap from laboratory to public health policy. *Br J Sports Med*. 2016;50(20):1231–1232. https://doi.org/10.1136/bjsports-2015-095705.
27. Galloza J, Castillo B, Micheo W. Benefits of exercise in the older population. *Phys Med Rehabil Clin*. 2017;28(4):659–669. https://doi.org/10.1016/j.pmr.2017.06.001.
28. Stevens M, Lieschke J, Cruwys T, et al. Better together: how group-based physical activity protects against depression. *Soc Sci Med*. 2021;286, 114337. https://doi.org/10.1016/j.socscimed.2021.114337.
29. Dunn AL, Trivedi MH, Kampert JB, et al. Exercise treatment for depression: efficacy and dose response. *Am J Prev Med*. 2005;28(1):1–8. https://doi.org/10.1016/j.amepre.2004.09.003.
30. Wu ZJ, Wang ZY, Gao HE, et al. Impact of high-intensity interval training on cardiorespiratory fitness, body composition, physical fitness, and metabolic parameters in older adults: a meta-analysis of randomized controlled trials. *Exp Gerontol*. 2021;150, 111345. https://doi.org/10.1016/j.exger.2021.111345.