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Combining motivational and exercise intervention components to reverse pre-frailty and promote self-efficacy among community-dwelling pre-frail older adults: a randomized controlled trial

Juan Fang[1,2†], Jianping Ren[1,4*†], Jinjing Wang[1], Xiantao Qiu[1], Shiyan Zhang[1], Shuang Yuan[1], Liangfeng Wu[1] and Lin Xie[3]

Abstract

Background Exercise is effective in preventing frailty status in older adults, but the effect of an exercise program based on Wellness Motivation Theory (WMT) on the frailty status, self-efficacy for exercise, and quality of life for older adults with pre-frailty remains unclear. Our objective was to examine the efficacy of a multicomponent exercise program based on WMT on frailty status, self-efficacy, and quality of life among pre-frail older adults.

Methods This was a randomized controlled trial of pre-frail older adults aged from 60 years to 85 years. Participants in the intervention group performed exercise three times a week for 24 weeks, once at a community health service station instructed by two researchers and two times at home. Participants in the control group were given one-time advice on physical activity. The assessor was the only one blinded. The primary outcome was the reversal rate of pre-frailty. The secondary outcomes included self-efficacy and quality of life.

Results One hundred and forty-four participants were randomized into two groups ($n=72$ in the intervention group and $n=72$ in the control group) and analyzed. After 24 weeks, the proportion of pre-frailty was significantly lower in the intervention group than in control (31.8% versus 74.6%, $P<0.001$). The absolute risk reduction was 42.8% [95% CI, 25.1–57.1]. In the 8th week and the 24th week, the frailty score of the intervention group was significantly lower than that of the control group. There were significant improvements in self-efficacy at week 2, week 8, and week 24. In weeks 8 and 24, participants in the intervention group reported a higher quality of life than the control group. There were no exercise-related injuries or falls among the participants.

Conclusions The exercise intervention based on WMT for pre-frail older adults could reverse pre-frailty, increase self-efficacy for exercise, and improve the quality of life in older Chinese.

†Juan Fang and Jianping Ren contributed equally to this work.

*Correspondence:
Jianping Ren
jpren2016@163.com

Full list of author information is available at the end of the article

Study registration details This study was registered in www.ClinicalTrials.gov on the 25th of July, 2024, with the identifier NCT06519695.

Reporting method The Consolidated Standards of Reporting Trials (CONSORT) checklist was used in this study for properly reporting how the randomized trial was conducted.

Keywords Aged, Frailty, Exercise, Self-efficacy, Quality of life

Background

Frailty is a common geriatric syndrome characterized by reduced functional reserves across multiple physiologic systems that increase vulnerability to adverse health outcomes when exposed to stressors [1]. Pre-frailty is an early stage of frailty [2]. A systematic review and meta-analysis reported a frailty prevalence of 46% among older adults [3]. More significant population numbers and fewer transitions in adults aged 50–64 present an opportunity for earlier identification and intervention, which may support positive long-term health outcomes and reduce the healthcare burden [4]. Multicomponent exercise programs have the most substantial evidence for frailty management [5].

We developed a multicomponent exercise program consisting of warm-up, aerobic training, resistance training, flexibility training, balance training, Traditional Chinese Medicine (TCM)-principle guided acupoint patting, and Baduanjin. Acupoint patting is a form of an evidenced non-pharmacological, non-invasive TCM treatment by striking to stimulate points of the body; it plays a role in unblocking meridian, disease prevention and has been found to improve psychological health [6]. Baduanjin is the most investigated form of qigong. It consists of eight sections of movements and is well suited for older adults because it is less cognitively and physically demanding than conventional exercise and other qigong forms. Previous study has demonstrated Baduanjin's feasibility and potential effects of reversing frailty status among older cancer survivors [7].

The Wellness Motivation Theory (WMT) posits that attention to social-contextual resources and behavioral-change processes facilitates health-related action [8]. Constructs in the WMT, including social resources, environmental resources, self-knowledge, readiness, and self-regulation, represent theoretically predicted mechanisms of change or processes. Interventions based on WMT have been successfully implemented to increase physical activity in community-dwelling older adults. A WMT-based intervention improved functional balance using fall-reducing physical activities in community-dwelling older adults [9]. In another study, a WMT-based intervention increased mobility and physical activity in older adults and improved self-regulation, self-efficacy, readiness, and social support for physical activity [10].

The barriers to exercise in frail patients are cultural and contextual [11]. Thus, we propose a novel multicomponent exercise intervention to address the main barriers, such as lack of motivation and low outcome expectations, in people with pre-frailty. The multicomponent exercise intervention is guided by WMT (Fig. 1). However, WMT-based intervention has not been tested in older adults with pre-frailty. Therefore, this study aimed to investigate the effects of a multicomponent exercise intervention based on WMT on frailty status, self-efficacy for exercise, and quality of life among pre-frail older adults, as this could be a relatively simple method for postponing the development of frailty and improving the quality of life in the old adults. We hypothesized that individuals participating in multicomponent exercise intervention based on WMT would reverse pre-frailty and experience more significant improvements in self-efficacy and quality of life. This was the first study that explored the effects of multicomponent exercise guided by WMT on community-dwelling older adults with pre-frailty.

Methods

Study design and participants

A two-arm, parallel-design, randomized controlled trial was conducted to test our hypotheses. The RCT was performed in four community health service sites of Ziyang and Mishixiang community health service centers in Hangzhou, Zhejiang Province, China, from 1 July 2022 to 31 December 2022. It was a single-blinded study, and the staff responsible for the evaluation was the only one blinded.

As the prevalence of frailty increases with age, older people aged 85 and over are more likely to be frail than those under 85 [12], and the participants were aimed at pre-frail older adults in this study. Besides, considering the safety of doing exercise, we referred to a previous study to determine the age range of participants [13].

The inclusion criteria were (1) pre-frail [12] older adults aged 60 to 85 years, (2) no moderate or severe cognitive impairments (Montreal Cognitive Assessment (MoCA) score ≥ 26 points), (3) no auditory or visual impairment, and (4) informed consent.

The exclusion criteria were as follows:1) suffering from chronic diseases that could affect their ability to exercise, and 2) regular exerciser (≥ three times per week, and ≥ 30 min every time).

Fig. 1 WMT framework for the multicomponent exercise program

Sample size and randomization

Regarding reversal in pre-frailty, the primary outcome, the sample size was calculated in G-power software with a ratio of 1:1. The protocol defined a 30% reversal of pre-frailty as the limit of detection of clinical importance. Based on previous studies [14–16], a 30% difference in reversing pre-frailty between the intervention and the control was assumed. The pre-frailty reversal rate in the intervention group was assumed to be 15% under the null hypothesis and 45% under the alternative hypothesis. The proportion of reversing pre-frailty in the control was assumed to be 10%. With a confidence interval (α) of 95%, 80% power of the study, and an intergroup difference of 30% in the reversal rate of frailty, the sample size would be 82 older adults. Assuming an attrition of 30%, the final number needed to recruit is 117 participants.

Two first batch of demonstration community health service centers in Zhejiang were typically selected in Shangcheng District and Gongshu District of Hangzhou, respectively. Then, an investigator with no intervention involvement prepared a computer-generated list of random numbers to assign two community health service sites from each center to the intervention or control group. Finally, the participants who met the inclusion criteria were chosen by two researchers (two postgraduate specializing in health management). A total of 144 pre-frail older adults were included, and they were divided into the intervention group (n=72) and control group (n=72) by random grouping.

Intervention group

The multicomponent exercise intervention based on WMT is presented in Table S1 in the Supplementary file. Intervention critical inputs included the exercise component and motivational component. The exercise intervention was scheduled for 24 weeks as follows: 47 min per session (5-minute warm-up, 10-minute aerobic training, 5-minute resistance exercise, 5-minute flexibility training, 5-minute balance training, 5-minute acupoint patting, and 12-minute Baduanjin), three times a week (one supervised community session and two home sessions) [14]. Social support, empowering education, and motivational support were used in the motivational session to improve participants' motivation [10]. The motivation enhancement activities were carried out monthly for about twenty minutes, each time after the supervised community exercise session. Two researchers (two PhD specializing in health management) worked to implement the intervention according to a standardized protocol. They were professionally trained in preventing and managing frailty and were not involved in data collection.

Control group

Participants in the control group received only a paper brochure about exercise advice, which recommended that older adults participate in at least 150 min of moderate to high-intensity exercise per week for at least 30 min each time. Participants in the control group maintained their usual lifestyle, and no exercise intervention was conducted.

Outcomes

Primary outcome

The primary outcome was the reversal rate of pre-frailty (from pre-frail to robust in this study). Pre-frailty was assessed by the Fried Phenotype model [12], including (1) the presence of unintentional weight loss, (2) exhaustion, (3) low physical activity, (4) reduced grip strength, and (5) low walking speed. The first three elements were self-reported criteria. Grip strength was measured by a grip dynamometer and stratified by gender and BMI. Walking speed was measured by walking 4.5 m and judged according to gender and height. Participants who fulfilled none of the criteria were considered robust, while those with 1–2 criteria were considered pre-frail, and those with three or more were referred to as frail. It is likely a valid measurement of frailty among older Chinese people [17].

Secondary outcomes

Secondary outcomes included self-efficacy for exercise and quality of life. The Self-Efficacy for Exercise Scale was designed to test people's confidence to continue exercising despite barriers to exercise [18]. It is a validated scale with nine items to measure the degree of confidence to exercise despite barriers. The score of each item ranged from 0 to 10, with higher scores representing greater exercise self-efficacy. The original English version of the scale was valid among older people [19, 20], and the Chinese version demonstrated satisfactory reliability and

validity [21]. Quality of life was assessed with the 12-item Short Form questionnaire version 1 (SF-12v1) [22], a simplified version of the SF-36 [23]. The SF-12 includes eight domains of general health, physical functioning, role-physical, bodily pain, vitality, social functioning, role-emotional, and mental health. The first four domains, including six items, are used to assess the physical component summary (PCS), and the last four, including six items, are used to assess the mental component summary (MCS). The total score for both scales ranges from 0 to 100, with a higher score indicating higher health-related quality of life (HRQoL).

Data collection

Sociodemographic information was collected at baseline. Primary outcome was collected at baseline (T0), eight weeks (T2), and 24 weeks (T3). Secondary outcomes were also collected at T1(2 weeks) besides T0, T2, and T3.

Statistical analysis

All analyses were performed using SPSS v22.0. The measurement data were presented as mean, and standard deviation. The classified data were described as frequency and percentage. Frailty status was compared by group using the chi-squared test. Absolute risk reduction (ARR) was calculated as: percentage of pre-frail participants in the control—the percentage of pre-frail participants in intervention group post-intervention. The 95% confidence interval of ARR is to be calculated by the Logit interval method. Generalized estimation equations analyzed all the variables. A Bonferroni adjustment was used to correct the three comparisons for frailty status; therefore, two-tailed p-values of <0.017 were considered statistically significant. For other analyses, the p-value of two-sided tests <0.05 was considered statistically significant. All analyses were per-protocol analyses.

Ethics

The study was approved by the Ethics Committee of the School of Public Health, Hangzhou Normal University (No. 20210012). All participants signed the informed consent form after the investigator explained the study.

Results

Participants' demographic and clinical characteristics

A total of 220 community-dwelling older adults were screened. Among them, 144 were enrolled in the trial and randomly allocated to the control group ($n=72$) or intervention group ($n=72$). Five participants in the control and six in the intervention group were lost to the follow-up. Figure 2 shows the study flow diagram. There were no exercise-related injuries or falls among the participants. There were 72 sessions for each participant in the intervention group; the attendance ranged from 43 to 72 times, averaging 62. The attendance rate was tracked using on-site check-in (researcher-reported) and exercise logs(self-reported).

Participants were between 60 and 85 years old, 94 (65.3%) were female, and all were assessed with pre-frailty with a mean Fried score of 1.58 ± 0.50. In the intervention group, the mean age of participants was 73.96 (7.20) years; 45 (62.5%) were female. Baseline sample characteristics for intervention and control groups are provided in Table 1; there was no group difference at baseline.

Frailty status and scores

The intervention produced a decrease in frailty, which is shown in Table 2. All the participants were classified as pre-frailty at pre-intervention. At 8 weeks of the intervention, 16.4% of the participants in the intervention group were classified as non-frailty, while in the control group, 4.3% were classified as non-frailty. After the intervention (week 24), the proportion of pre-frailty was significantly lower in the intervention group than the control (31.8% versus 74.6%, $P<0.001$). The ARR was 42.8% [95% CI, 25.1–57.1].

Linear mixed-effects model of frailty scores between exercise and control groups across time are presented in Table S2. There was a significant group*time effect. Simple effects showed intragroup differences in the intervention group; changes from baseline were significant, -0.58 (-0.76~-0.35) for week 8, and −1.06(-1.31~-0.82) for week 24, p all <0.001. At the same time, there was no significant difference in the control group, as seen in Table S3. Comparisons of frailty scores across time are presented in Table S4. Compared to the control, the intervention group presented significantly lower frailty scores both at week 8 and week 24.

Self-efficacy for exercise

Table 3 shows that the interaction effect of group-by-time was significant ($p<0.001$). The results of intragroup and intergroup comparisons were presented in Tables S5 and S6, respectively. In the intervention group, the scores of self-efficacy were significantly higher at week 2, week 8, as well as week 12 compared to that at the baseline (p all <0.001); in the control group, there was a significant increase only at week 2 ($p=0.014$), and no significant difference at week 8, and week 24 compared with that at the baseline. Intergroup comparisons at week 2, week 8, and week 24 displayed significantly higher self-efficacy scores in the intervention group compared to the control group (p all <0.001).

Quality of life

Table S7 depicts the comparisons for the quality of life between exercise and control groups across time. The

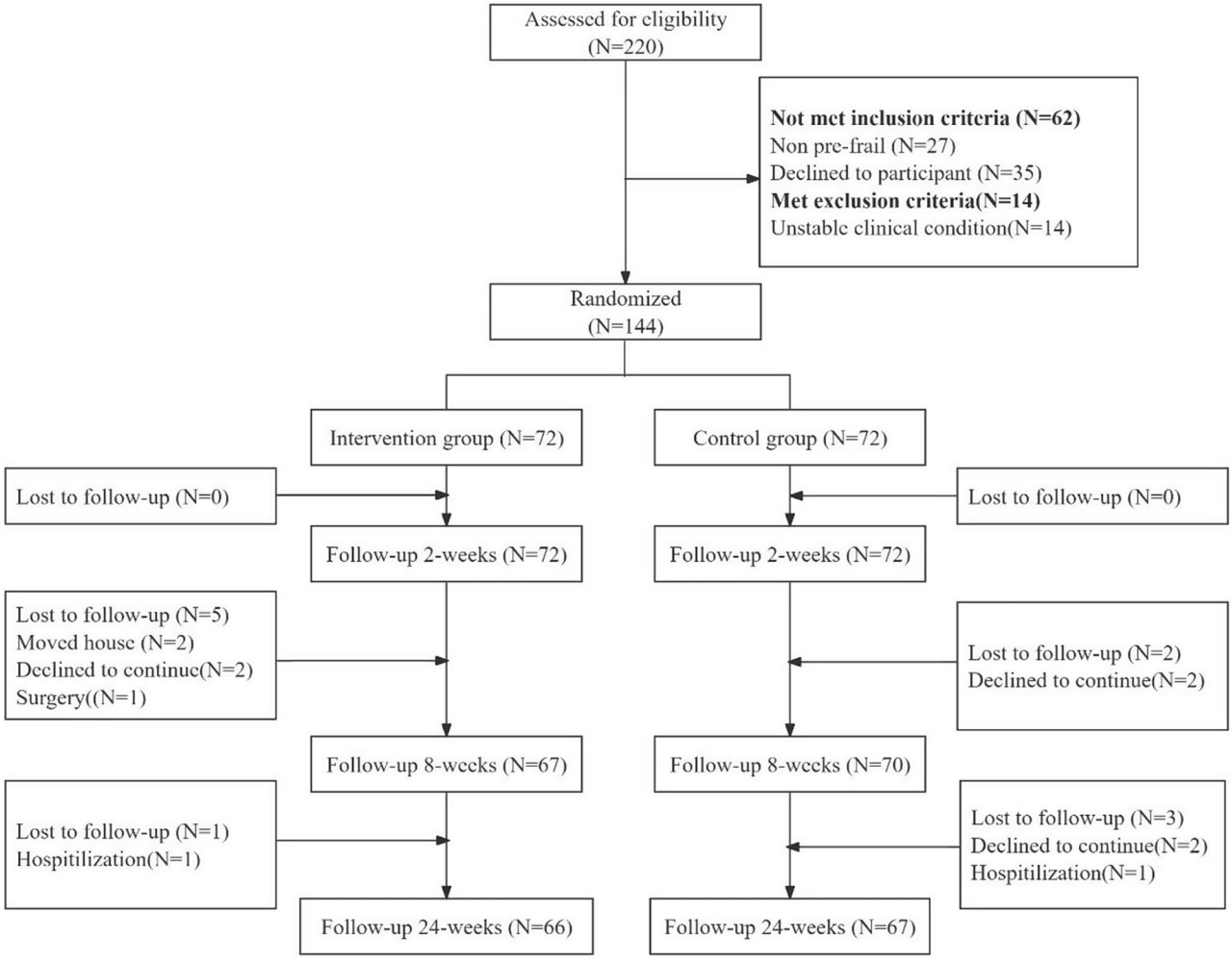

Fig. 2 Study flow diagram through the trial

interaction effects of group-by-time according to the linear mixed-effect model were significant for the PCS and MCS ($p<0.001$). The results of intragroup comparisons (Table S8) displayed that, in the intervention group, the scores of the PCS were significantly higher compared to baseline at week 8 ($p<0.001$) and week 24 ($p<0.001$). In comparison, the scores of the MCS at week 2 ($p=0.038$), week 8 ($p<0.001$), and week 24 ($p<0.001$) were consistently higher than those at baseline. However, in the control group, the scores at week 2, week 8, and week 24 were not significantly different from those at the baseline for both PCS and MCS. About the intergroup comparisons (Table S9), PCS and MCS scores were significantly higher than those in the intervention group at week 8 and week 24. In contrast, the scores for both outcomes remained insignificant between the two groups at week 2.

Discussion

The results from this study provide evidence that the multicomponent exercise program based on WMT has positive effects on pre-frailty reversal, self-efficacy, and quality of life among older adults with pre-frailty.

The main finding of this study is that the multicomponent exercise intervention based on WMT could reverse pre-frailty. The reversal rate of pre-frailty was 16.4% at week 8 and 63.6% at week 24. Previous studies have shown that multicomponent exercise was more effective in improving frailty than single exercise because it combines the advantages of different exercises [24]. TCM-principle guided acupoint patting has been demonstrated to be a supplementary multicomponent exercise component in pre-frail older adults to reverse pre-frailty, in which the reversal rate in another study was 86% after three months of intervention [14]. The reversal rate in this study was higher than in our study because the exercise interventions were conducted under intensive guidance by professionals in the community. Barrachina-Igual

Table 1 Baseline demographic and clinical characteristics of participants

Characteristic	Intervention group (*n* = 72)	Control group (*n* = 72)	*p*-value
Age, years	73.96 ± 7.20	72.92 ± 6.36	0.359
Sex, *n* (%)			
Male	27(37.5)	23(31.9)	0.484
Female	45(62.5)	49(68.1)	
Educational level, *n* (%)			0.553
Primary school or lower	19(26.4)	17(23.6)	
Junior high school	36(50.0)	33(45.8)	
Senior high school	7(9.7)	13(18.1)	
Junior college or higher	10(13.9)	9(12.5)	
Marital status, *n* (%)			0.851
In marriage	52(72.2)	53(73.6)	
Others (Unmarried, divorced, widowed)	20(27.8)	19(26.4)	
Monthly income, *n* (%)			0.865
≤ 3999¥	15(20.8)	15(20.8)	
4000–6999¥	50(69.4)	48(66.7)	
≥ 7000¥	7(9.7)	9(12.5)	
Occupation before retirement, *n* (%)			0.677
In charge of enterprises and institutions/administrative personnel	12(16.7)	10(13.9)	
Professionals	9(12.5)	14(19.4)	
Workers	39(54.2)	35(48.6)	
Others	12(16.7)	13(18.1)	
Living status, *n* (%)			0.820
Solitary	11(15.3)	12(16.7)	
Non-solitary	61(84.7)	60(83.3)	
Smoking, *n* (%)			
Yes	12(16.7)	8(11.1)	0.335
No	60(83.3)	64 (88.9)	
Drinking, *n* (%)			
Yes	15(20.8)	10(13.9)	0.271
No	57(79.2)	62(86.1)	
Frailty	1.64 ± 0.48	1.51 ± 0.50	0.131
Self-efficacy for exercise	2.15 ± 0.86	2.25 ± 0.92	0.513
PCS	36.18 ± 8.18	37.11 ± 8.15	0.492
MCS	40.26 ± 8.00	39.05 ± 7.43	0.347

Note PCS, physical component summary; MCS, mental component summary

Table 2 Comparisons of frailty status for the intervention and control groups

Time	Frailty status	Intervention group	Control group	χ^2	*p*-value
		n (%)	*n* (%)		
Week 8	Non-frailty	11(16.4)	3(4.3)	5.556	0.062
	Pre-frailty	54(80.6)	64(91.4)		
	frailty	2(3.0)	3(4.3)		
Week 24	Non-frailty	42(63.6)	9(13.4)	35.465	< 0.001
	Pre-frailty	21(31.8)	50(74.6)		
	frailty	3(4.5)	8(11.9)		

et al. reported that the reversal rate of pre-frailty was 39% [15]. This may be due to the lower frequency and shorter duration of the intervention and the older age of the participants compared with our study. Our study also found that the longer the intervention, the better the improvement in frailty. In addition, a 24-week intervention could bring significant large changes in the frailty scores in older adults with pre-frailty compared to that in the control group [25].

This study showed that multicomponent exercise based on WMT could improve self-efficacy for exercise. The intervention is based on the WMT, which posits that social contextual resources, such as environmental and social support, and behavioral change processes, such as self-knowledge, readiness, and self-regulation, influence older adults' health-related actions, including physical activity [10]. Self-efficacy for exercise refers to a belief in one's capability to successfully execute the actions of exercise necessary to satisfy specific situational demands [26]. One possible reason for improving self-efficacy was that social support, motivational support, and empowerment education strategies in the intervention played an important role. In particular, motivational support could effectively improve the self-efficacy of individual behavior, make full use of social contextual resources, and transform individual goals into desired results [8]. This is consistent with the previous research results of Yeom et al. [10], which supported that older adults receiving motivational physical activity intervention would show significantly improved social resources, behavioral change processes, physical activity, and mobility over attention control participants. In addition, the intervention group adopted the combination of home intervention and community group intervention, which not only realized the supervision and guidance in the process but also reduced the restrictions of on-site intervention time and venue and strengthened the confidence of the elderly to insist on exercise. In the control group, the exercise self-efficacy score was significantly improved in the second week of intervention, indicating that the combination of 1-time advice on exercise and paper brochures could improve the self-efficacy of the elderly in the short term. Some motivational support strategies are needed to maintain the long-term effect [10].

This study showed that multicomponent exercise based on WMT positively affects the quality of life of pre-frail older adults. The results showed that during the eighth week of the intervention, exercise intervention could significantly improve the total score of PCS and MCS of the pre-frail elderly in the community. There was no significant change in the control group. A previous study [24] showed that the home multicomponent exercise (balance, strength, and flexibility training) intervention program based on information technology could

Table 3 Linear mixed-effects model of self-efficacy scores

Outcome	Time	Intervention group ($n=66$)	Control group ($n=67$)	Linear mixed-effects model (p-value)		
				Group	Time	Group*time
Self-efficacy	Baseline	2.15 ± 0.86	2.25 ± 0.92	< 0.001	< 0.001	< 0.001
	Week 2	3.02 ± 0.68	2.62 ± 0.35			
	Week 8	3.42 ± 1.12	2.48 ± 0.29			
	Week 24	6.67 ± 1.16	2.58 ± 0.99			

significantly improve the MCS of elderly people with pre-frailty in the community. In the intervention process, on the one hand, the interaction between the participant and the instructor has a positive impact on the participant. On the other hand, through the platform set up by the program organizer, the elderly can get to know groups with similar backgrounds and interests, expand interpersonal communication, strengthen the construction of social support network through communication and interaction, improve the level of socialization and social health [14], and thus promote mental health and emotional health [26]. In addition, the PCS score of the intervention group was also significantly improved. The more severe the frailty, the worse the health-related quality of life [27]. With the improvement of exercise-related self-efficacy, elderly people's exercise involvement, and social participation increase, and their subjective feelings of general health, physical functioning, role-physical, and bodily pain also increase. This conclusion has been confirmed in previous studies [28].

The attendance rate (86%) in this study was higher than that in a previous study (73.54%) [15]. On the one hand, home practice twice weekly reduces exercise time and space limitations for the elderly. On the other hand, home practice twice weekly reduced exercise time and space limitations for the elderly. However, the attendance rate in our study was lower than in another similar study conducted in Canada (88.3%) [27]. The possible reason was that all the participants in that study were women. Women were reported to have better attendance in exercise programs than men [28].

Limitations

There are some limitations to this research. Firstly, participants and researchers conducting the interventions were not blinded to the groups' assignment. Secondly, the participants recruited are limited to community-dwelling pre-frail older adults, so the results cannot be extrapolated to the rest of the population. Thirdly, this study investigated the effects of a multicomponent program without different training groups. It would be interesting if future studies investigated this issue, e.g., comparing the results of a multicomponent program with motivational intervention and the same multicomponent program without motivational intervention. Finally, the study did not investigate the effects of the intervention after the program. We cannot determine whether the results would differ during the following time.

Conclusion

A 24-week exercise program based on WMT is an effective training method for pre-frail people since it is a viable way to reverse pre-frailty and optimize improvements in self-efficacy and quality of life.

Abbreviations

WMT	Wellness Motivation Theory
PCS	Physical component summary
MCS	Mental component summary
HRQoL	Health-related quality of life
RPE	Rating of Perceived Exertion

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12877-024-05464-6.

Supplementary Material 1

Supplementary Material 2

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Author contributions

R.J.P. designed the study, supervised the sample recruitment and data collection. F.J. drafted the manuscript, analyzed the data and interpreted the results. W.J.J., Q.X.T., Z.S.Y., Y.S., W.L.F. and X.L. participated in acquiring subjects and collecting data. All authors reviewed the manuscript.

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Data availability

The datasets generated during and analyzed during the current study are not publicly available due to the privacy but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study was approved by the Ethics Committee of the School of Public Health, Hangzhou Normal University. Following an explanation of the purpose of the study, informed consent was obtained from those patients who met the eligibility criteria and agreed to participate.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Author details
[1]School of Public Health, Hangzhou Normal University, Hangzhou 311121, China
[2]School of Medicine, Huzhou University, Huzhou 313000, China
[3]School of Clinical Medicine, Hangzhou Normal University, Hangzhou 311121, China
[4]Engineering Research Center of Mobile Health Management System, Ministry of Education, Hangzhou Normal University, Hangzhou 311121, China

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