Original Research

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Effect of Multicomponent Intervention on Functional Decline in Chinese Older Adults: A Multicenter Randomized Clinical Trial

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Abstract

OBJECTIVES: To confirm whether multicomponent exercise following vivifrail recommendations was an effective method for improving physical ability, cognitive function, gait, balance, and muscle strength in Chinese older adults.

METHODS: This was a multicenter and randomized clinical trial conducted in Jiangsu, China, from April 2021 to April 2022. Intervention lasted for 12 weeks and 104 older adults with functional declines were enrolled. All participants were randomly assigned to a control (usual care plus health education) or exercise group (usual care plus health education plus exercise). Primary outcomes were the change score of Short Physical Performance Battery (SPPB) and activities of daily living (ADL). The secondary outcomes included instrumental activities of daily living, Tinetti scores, Frailty score, short-form Mini Nutritional Assessment, Mini-Mental State Examination, Geriatric Depression Scale-15, the 12-item Short Form Survey, 4-meter gait speed test, 6-min walking distance, grip strength, and body composition analysis.

RESULTS: Among the participants, the average age was 85 (82, 88) years. After 12 weeks of follow-up, the exercise group showed a significant improvement in SPPB, with a change of 2 points (95% confidence interval [0, 3.5], P<0.001) compared to control. In contrast, SPPB remained stable in the control group. Compared to the control group, ADL improved in the exercise group, as did instrumental activities of daily living, Tinetti, Frailty, Short Form Survey, 4-meter gait speed test, and 6-min walking distance. Although there was no significant difference between groups in body composition analysis after post-intervention, the exercise group still improved in soft lean mass (P=0.002), fat-free mass (P=0.002), skeletal muscle mass index (P<0.001), fat-free mass index (P=0.004), appendicular skeletal muscle mass (P<0.001), and leg muscle mass (P<0.001), while the control group had no significant increase. No difference was observed in adverse events during trial period.

CONCLUSIONS: The multicomponent exercise intervention following vivifrail recommendations is an effective method for older adults with functional decline and can reverse the functional decline and improve gait, balance, and muscle strength. Additionally, the 12-week multicomponent exercise method provides guidance for Chinese medical professionals working in the field of geriatrics and is a promising method to improve physical function in the general population.

Key words: Multicomponent intervention, functional decline, randomized clinical trial.

Introduction

Age-related functional decline in physical performance has become a common phenomenon in the aging population (1). Generally, functional assessment means objective evaluation of a person's status, such as physical health, quality of self-maintenance, intellectual status, social activity, attitude toward the world and themselves, emotional status, and life satisfaction. Hospitals, communities, nursing homes, and homes have a high prevalence of functional decline. However, it was rare to identify functional status in older adults over time. Currently, the common predictor factors for the functional decline are age, dementia, comorbidities, polypharmacy, admission diagnosis, and physical activity, among others (2). As for the specific presentations about functional decline, they have been described variously in previous studies, such as increased health care use, loss of independence ability in society, increased rate of hospitalization, and prolonged hospitalization and increased risk of mortality (3, 4). The functional decline in elderly adults also indicates damage to lower muscle strength, balance performance, grip strength, gait, mobility, and self-care abilities, etc (5, 6). Physical performance measures and intervention in aging-related fields appear to be particularly important (7). Maintaining independence in older adults is a significant goal, particularly for those who have remained at the greatest risk of physical function decline and disability (5). If the process of functional decline is not stopped before it worsens, elderly adults can easily become disabled.

Notably, disability is not the final state from which an individual can recover based on intervention, including exercise (8). A longitudinal study of aging included 7,000 individuals, and after 6 years of follow-up, it showed that the program involved in physical activity exerted a protective role on functional ability (9). Another prospective cohort study found that nondisabled older adults living in the community, had a high risk of subsequent disability (10). Early screening, intervention, and management of functional status among older adults may be a good strategy to prevent disability in the aging process.

Older adults with disabilities usually require enormous costs and medical resources. The number of elderly Chinese

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people with disabilities was 52.7 million in 2020, which is projected to exceed 77 million by 2030 without intervention (11). Currently, over 1 billion people, or approximately 16% of the global population, are experiencing significant disability. Older adultsrepresent a significant proportion of people with disabilities.

Some studies have confirmed the strong relationship between exercise and physical health, such as enhancing cardiovascular function, improving cognitive function, increasing muscle strength, reversing frailty, and improving quality of life (12-16). The multicomponent exercise intervention, which includes strength, endurance, and balance training, appears to be an effective method for maintaining a good physical status in elderly adults (17). Currently, several studies have demonstrated that multicomponent intervention is an effective method to reverse aging-related physical status (18-20). The 2021 International Exercise Recommendations in Older Adults put forward that exercise plays important roles and could be regarded as a preventive strategy for many chronic diseases (8). Although multicomponent exercise benefits are well recognized, to the best of our knowledge, there have been no standardized prospective clinical trials on functional decline in the Chinese older population.

China has the world's largest older population, accounting for 18% of the total population, with 164.5 million individuals aged 65 years in 2019, and the number of older adults is projected to double by 2050 (21). Therefore, it is crucial to conduct the intervention of value among the Chinese population and explore whether the data differ from that of American and European countries. In this study, we aimed to confirm whether multicomponent exercise following vivifrail recommendations was an effective method for improving physical ability, cognitive function, gait, balance, and muscle strength in Chinese older adults. We hypothesized multicomponent exercise among Chinese older adults is a valid method to improve physical function.

Methods

Study Design and Study Participants

This is a prospective multicenter randomized controlled trial (RCT) to identify functional decline and explore the effectiveness of the intervention at an early stage, facilitate unified management, and improve the quality control level. Six nursing homes were selected in the Nanjing area, Jiangsu, China. This clinical trial was planned from 2018 to 2022, and we screened 302 participants from April 2021 to April 2022. All eligible older adults were randomly assigned to a control group (usual care plus health education) or exercise group (usual care plus health education plus exercise). Scientific exercise mainly including exercise style, time, and exercise security. Exercise training were consistent with stretch, aerobic, progressive resistance, and balance exercises. Training intensity starts at low intensity and gradually increases to appropriate intensity gradually. Appropriate intensity and time focus on personal situations where participants feel comfortable and can talk freely. During the research period, at least one experienced medical staff member accompanied the individual to ensure exercise security and effectiveness. In the study, we used stratified randomization, and stratified factors were the research center. The detailed operation methods were as follows: Qualified individuals were screened; subsequently, researchers obtained information from randomized participants through the central Randomization system (IWRS). Randomization sequences were generated using the IWRS system (http://58.213.51.73:9080/newHTEDC/). Before randomization, all individuals underwent face-to-face communication and answered related questions. Finally, 104 older adults were enrolled in this study. There was no financial compensation. This intervention lasted for 12 weeks, and all participants were assessed at three time points (baseline, 6 weeks, and 12 weeks). Further details are showed in Supplementary Document 1. All participants provided written informed consent, and the clinical protocol was reviewed and approved by the ethics committees of NJMU; the ethical number was 2020-SR-72. This clinical trial was registered (https://www.clinicaltrials.gov) with the trial number, ChiCTR2000040328.

Eligibility Criteria

The inclusion criteria were as follows: 1) adults aged 65 years or older, regardless of sex; 2) Barthel index ≥60 points; 3) maintained a stable health condition without severe dementia; 4) the participants could be followed up more than 12 weeks. Participants who presented worsening of some condition, with need for hospitalization or those people whose compliance was poor and could not continue to cooperate with the implementation of intervention measures through communication were excluded from the study.

Intervention Program

Health Education

Health education was conducted twice a month, each session lasting 30–50 min. The contents focused on a healthy diet, scientific exercise, and the related importance and were introduced by professional physical therapists and nutritionists.

Exercise Intervention

The exercise intervention was performed based on the 2020 International Exercise Recommendations in Older Adults and vivifrail multicomponent intervention (22, 23). The exercise group performed multicomponent exercises as follows: low intensity (50%–65% HRmax) exercise time controlled 30–40 min, and medium intensity (65%–75% HRmax) recommended 20–30 min. Experimental group comprised the following four parts: 1) warm-up (5–10 min), slow running or stretching were chosen; 2) aerobic exercise (20–40 min), including walking outdoors, biking, or hydrotherapy; 3) progressive resistance session, starting at 30% of one repetition maximum, with 10–12 per groups and 3–5 groups per day; and 4) balance exercise, involving remaining in the same position and persisting 30 seconds, repeated 3–5 times, such as standing on double, front, and back feet and other Chinese traditional activities, including Taichi, Baduanjin.

Measures

Demographic data, clinical diagnoses, and medication history were collected. The physical performance was assessed using Short Physical Performance Battery (SPPB) scale, 4-meter gait speed test (4MGS), and 6-min walking distance (6MWD). SPPB, 4MGS, and 6MWD have been described in previous studies (23, 24). Hand grip strength (HGS) was measured for both the dominant and non-dominant hand (25). Functional capacity and social activities were evaluated using the instrumental activities of daily living (IADL) and activities of daily living (ADL) (26, 27); quality of life and emotional health were assessed using the 12-item Short Form Survey (SF-12) and Geriatric Depression Scale-15 (GDS-15) (28, 29); Nutritional status was assessed using the short form Mini Nutritional Assessment (MNA-SF) (30). The balanced state was estimated using Tinetti score and cognitive function was calculated using the Mini-Mental State Examination (MMSE) (31, 32). All scales and data were recorded using the designed APP (2021SR0437260) and assessed at baseline, 6 weeks, and 12 weeks. Additionally, body composition was measured using multifrequency bioelectrical impedance analysis (MF-BIA) (InBodyS10, Biospace, Korea).

Outcomes

The primary outcomes were the changes in SPPB and ADL from baseline to 12 weeks (24). The meaningful clinical change was defined as an increase of 1 point for the SPPB or 5 points for the ADL. The secondary outcomes included IADL, Tinetti scores, Frailty score, MNA-SF, MMSE, GDS-15, SF-12, 4MGS, 6MWD, HGS, and body composition.

Sample Size Calculations

Combined with the previous study, SPPB was regarded as the primary evidence (18). Participants in the exercise and control groups were matched at 1:1.5. Assuming an alpha error of α=5%, a correlation between pre-and post-intervention values of SPPB of ρ=0.5, and a standard deviation for SPPB of σ=1.5, the required sample size to achieve a power of 80% to detect a minimum difference of 1 point between groups in the post-pre SPPB score.

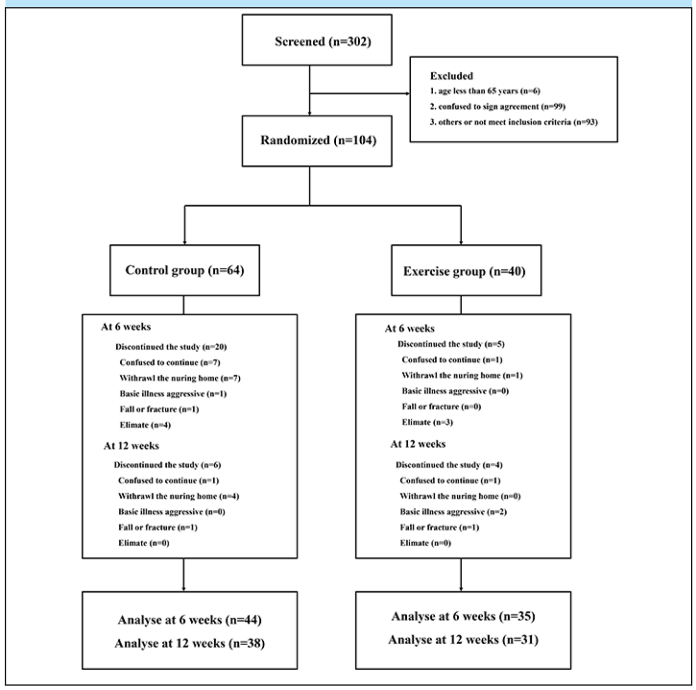
The sample size was calculated using PASS15.0.5, and 56 and 37 individuals were estimated in the control and exercise groups, respectively; overall, 93 people needed to be randomized for the efficacy analysis. Eventually, we included 104 individuals (64 and 40 people in control and exercise groups, respectively) in this clinical trial.

Statistics

First, we checked the distribution of quantitative data was normal or abnormal using Shapiro-Wilk test. Continuous univariate of the normal distribution is expressed as mean ± standard deviation (SD) while abnormal distribution is expressed as a median (quartile). Categorical variables are presented as frequency (percentage, %). The comparison between two groups (experiment and control groups) were performed using two-independent sample t-test or the Mann–Whitney test for continuous variables; the Chi-square (χ^2) test or Fisher's exact test for categorical variables. In addition, this research performed paired sample t test or Wilcoxon signed rank test to examine whether there is a statistically significant difference in a group of participants before and after the experiment. Besides, Analysis of Variance (ANOVA) of repeated measurement data or Generalized Estimating Equations (GEE) analysis has been carried out to test the difference between groups with the influence of clinic intervention and the time.

All statistical analyses were performed using SPSS 23.0, and $P< 0.05$ was considered statistically signifcant.

Figure 1. Flowchart of the participants' selection process



Results

Baseline Characteristics

Figure 1 shows the study flow diagram. Overall, 302 eligible older adults were screened. Among them, 104 were enrolled and randomly assigned to control (n = 64) or exercise group (n = 40). Table 1 describes total population characteristics. No statistical difference was found in the baseline regarding physical ability, cognitive function, grip strength, balance, gait, quality of life, and nutritional status; these results are

Table 1. Demographics and clinical characteristics in the control and exercise groups

Characteristics	Control (N=60)	Exercise (N=44)	All (N=104)
Age, years	86(83–89)	83(80–87)	85(82–88)
Height, cm	160(10)	158(9)	159(10)
Heartrate, bpm	71(64–83)	71(64–81)	71(64–80)
Sex, %			
male	27(45)	18(41)	45(43)
female	33(55)	26(59)	59(57)
Education, %[a]			
low	16(27)	7(16)	23(22)
high	44(73)	37(84)	81(78)
BMI, %			
<20	2(4)	2(4)	4(4)
20–30	52(94)	39(89)	91(92)
≥30	1(2)	3(7)	4(4)
Blood pressure, mmHg			
Systolic	145(21)	143(19)	144(20)
Diastolic	80(15)	79(12)	79(14)
Comorbidity, %			
Cardiovascular disease	36(60)	26(59)	62(60)
Diabetes mellitus	12(20)	6(14)	18(17)
Pulmonary diseases	1(2)	2(4)	3(3)
Stroke or TIA	9(15)	6(14)	15(14)
Scale score			
MNA-SF	13(12–14)	13(12–14)	13(12–14)
SPPB	5.5(4–8)	7(4–9)	6(4–9)
ADL	95(85–100)	100(90–100)	95(90–100)
IADL	16(11.8–21.3)	19(14–23)	17(12–22)
Tinetti	23.5(18.0–26.3)	25(21–27)	25(20–27)
FRAIL	2(0–2)	1(0–2)	1(0–2)
MMSE	26(21.8–29.3)	25(23–28)	26(22–29)
GDS-15	3(1–6)	2(1–4)	2(1–4)
SF-12	70.7(20.7)	78.1(74.0)	74.0(21.6)
Grip strength, kg			
Dominant hand	17.7(7.5)	19.6(6.6)	18.5(7.2)
Non dominant hand	14.5(7.9)	16.8(6.4)	15.5(7.3)
6MWD, m	220(132)	271(125)	243(131)
4MGS, m/s	0.7(0.4-1.0)	0.8(0.5–1.0)	0.7(0.4–1.0)
Body Composition			
Weight, kg	64.0(10.3)	63.4(10.0)	63.7(10.1)
Total Body Water, L	31.0(6.4)	30.2(5.2)	30.7(5.9)
TBW/FFM, %	73.9(73.8–74.3)	73.9(73.6–74.2)	73.9(73.7–74.2)
Fat mass, kg	22.0(6.1)	22.6(6.1)	22.3(6.1)
Soft Lean Mass, kg	39.0(33.1–45.8)	39.1(33.2–43.5)	39.1(33.2–44.1)
Fat-free mass, kg	42.0(8.7)	40.9(6.8)	41.5(7.9)
Percent Body Fat, %	35.1(28.9–40.7)	36.1(30–39.7)	35.2(30.0–40.2)

Table 1 (continued). Demographics and clinical characteristics in the control and exercise groups

Characteristics	Control (N=60)	Exercise (N=44)	All (N=104)
Body Mass Index, kg/cm^2	25.2(3.0)	25.2(3.1)	25.2(3.0)
Body Fat Mass, kg	-11.5(5.7)	-12.0(5.7)	-11.7(5.7)
Bone Mineral Content, kg	2.4(0.5)	2.4(0.3)	2.4(0.4)
Arm Circumference, cm	28.0(2.5)	28.3(2.6)	28.1(2.5)
AMC, cm	23.4(1.8)	23.6(2.1)	23.5(1.9)
Waist circumference, cm	76.0(9.5)	77.1(10.1)	76.5(9.7)
VFA, cm^2	105.2(34.8)	107.2(35.4)	106.1(34.9)
SMI, kg/m^2	7.2(1.2)	7.1(1.1)	7.14(1.14)
Fat-free mass index, kg/m^2	16.4(1.8)	16.2(1.5)	16.3(1.7)
ASM, kg	18.5(4.8)	18.0(4.4)	18.3(4.6)
Leg muscle mass, kg	14.5(11.2–17.8)	13.7(11.6–18.1)	14.1(11.6–17.8)
Lean body mass, kg	42.0(8.7)	40.9(6.8)	41.5(7.9)

6MWD, 6-min walking distance; 4MGS, 4-metre gait speed test; SPPB, Short Physical Performance Battery; ADL, activities of daily living; MNA-SF, short form mini nutritional assessment; MMSE, Mini-Mental State Examination; GDS-15, geriatric depression scale-15; SF-12, the 12-item Short Form Survey; VFA, Visceral Fat Area;SMI: skeletal muscle index; AMC, Arm Muscle Circumference; ASM, appendicular skeletal muscle mass. a. Edcuation low means ≤ 12 years; education high means ≥ 12years.

Table 2. Results of primary and secondary outcomes between the control and exercise groups

	Control Group	Exercise Group	P value[a]
Primary outcomes			
SPPB			
baseline	6(4–8)	6.5(4–9)	0.254
6 weeks	5(3–7)	8(4–9)	0.022
12 weeks	4(3–6.5)	7(5–10)	<0.001
ADL			
baseline	95(85–100)	90(90–100)	0.439
6 weeks	95(90–100)	100(92.5–100)	0.036
12 weeks	95(85–100)	100(100–100)	<0.001
Secondary outcomes			
IADL			
baseline	16(11.8–21.3)	19(14–23)	0.161
6 weeks	15(12–20)	17(12–21)	0.102
12 weeks	14(8–18)	18(14–23)	<0.001
Tinetti			
baseline	23(18–26)	25(21–27)	0.404
6 weeks	22(15–25)	25(21–26)	0.034
12 weeks	21(11.5–24)	24(22–26)	<0.001
MNA-SF			
baseline	13(12–14)	13(12–14)	0.529
6 weeks	13(12–14)	14(13–14)	0.043
12 weeks	13(12–14)	14(12–14)	0.316
FRAIL			
baseline	2(0–2)	1(0–2)	0.077
6 weeks	2(1–2)	1(0–2)	0.001
12 weeks	2(1–2)	1(0–1)	<0.001
MMSE			
baseline	26(22–29)	25(23–28)	0.56
6 weeks	28(24–30)	28(23–30)	0.546
12 weeks	28(21–30)	28(26–30)	0.210
GDS-15			
baseline	3(1–6)	2(1–4)	0.204
6 weeks	3(1–4)	2(1–4)	0.176
12 weeks	2(1–4)	2(1–3)	0.413

Table 2 (continued). Results of primary and secondary outcomes between the control and exercise groups

	Control Group	Exercise Group	P value[a]
QoL (SF-12)			
baseline	70.6(20.7)	78.1(22.3)	0.056
6 weeks	70.0(19.0)	77.3(15.6)	0.075
12 weeks	66.0(19.3)	78.4(14.7)	0.003
Grip strength, kg			
Dominant hand			
baseline	17.7(7.5)	19.6(6.6)	0.251
6 weeks	18.8(7.6)	19.5(8.1)	0.950
12 weeks	17.6(6.5)	19.2(6.3)	0.268
Non dominant hand			
baseline	14.5(7.9)	16.8(6.4)	0.113
6 weeks	15.1(7.1)	16.6(8.1)	0.400
12 weeks	13.2(6.8)	16.6(6.1)	0.038
6MWD, m			
baseline	220.0(132.3)	271.3(125.1)	0.052
6 weeks	195.7(121.6)	259.7(139.1)	0.036
12 weeks	184.3(101.7)	299.1(120.2)	<0.001
4MGS, m/s			
baseline	0.7(0.4,1)	0.8(0.5,1)	0.111
6 weeks	0.5(0.4,1)	0.8(0.5,1)	0.012
12 weeks	0.5(0.4,0.9)	1.0(0.6,1.3)	0.001
Body Composition			
Weight, kg			
baseline	64.0(10.3)	63.4(10.0)	0.794
6 weeks	66.9(11.1)	63.8(10.7)	0.230
12 weeks	68.1(17.9)	63.9(10.6)	0.257
Body Mass Index, kg/m²			
baseline	25.2(3.0)	25.2(3.1)	0.583
6 weeks	25.9(2.9)	26.0(3.5)	0.744
12 weeks	35.7(64.0)	25.7(3.4)	0.302
Total Body Water, L			
baseline	31.0(6.4)	30.2(5.2)	0.503
6 weeks	32.6(6.9)	30.2(5.8)	0.107
12 weeks	43.1(73.0)	30.9(5.7)	0.392
TBW/FFM, %			
baseline	73.9(73.8–74.3)	73.9(73.6–74.2)	0.458
6 weeks	74(73.7–74.3)	73.9(73.7–74.1)	0.581
12 weeks	73.8(73.7–74.2)	74.0(73.7–74.1)	0.628
Fat mass, kg			
baseline	22.0(6.1)	22.6(6.1)	0.652
6 weeks	22.7(5.1)	22.9(6.7)	0.700
12 weeks	22.1(5.6)	22.1(6.5)	0.727
Soft Lean Mass, kg			
baseline	39.0(33.1–45.8)	39.1(33.2–43.5)	0.511
6 weeks	40.2(35.6–47.4)	37.7(32.5–43.6)	0.113
12 weeks	39.9(34.1–47.8)	38.0(34.1–44.1)	0.400
Fat-free mass, kg			
baseline	42.0(8.7)	40.9(6.8)	0.495
6 weeks	44.1(9.4)	40.8(7.7)	0.108
12 weeks	46.1(19.7)	41.8(7.5)	0.380
Percent Body Fat, %			
baseline	35.1(28.9–40.7)	36.1(30.0–39.7)	0.699
6 weeks	34.8(28.4–39.2)	36.2(30.6–41.2)	0.328
12 weeks	35.4(27.6–39.4)	35.2(28.5–39.2)	0.926

Table 2 (continued). Results of primary and secondary outcomes between the control and exercise groups

	Control Group	Exercise Group	P value[a]
Body Fat Mass, kg			
baseline	-11.5(5.7)	-12.0(5.7)	0.637
6 weeks	-12.2(4.5)	-12.4(6.2)	0.866
12 weeks	-11.8(4.9)	-11.4(6.0)	0.747
Bone Mineral Content, kg			
baseline	2.4(0.5)	2.4(0.3)	0.615
6 weeks	2.6(0.6)	2.4(0.4)	0.084
12 weeks	-8.8(74.4)	2.4(0.3)	0.335
Arm Circumference, cm			
baseline	28.0(2.5)	28.3(2.6)	0.642
6 weeks	28.0(2.5)	28.2(2.5)	0.847
12 weeks	34.3(43.4)	27.9(2.6)	0.939
AMC, mean(SD), cm			
baseline	23.4(1.8)	23.6(2.1)	0.512
6 weeks	23.7(2.1)	23.7(1.2)	0.974
12 weeks	25.7(17.1)	23.4(2.2)	0.731
Waist circumference, cm			
baseline	76.0(9.5)	77.1(10.1)	0.572
6 weeks	75.7(8.4)	75.2(9.9)	0.552
12 weeks	73.9(7.7)	73.2(8.1)	0.619
VFA, cm^2			
baseline	105.2(34.8)	107.2(35.4)	0.779
6 weeks	101.4(25.5)	103.8(38.7)	0.764
12 weeks	96.2(30.0)	95.5(33.0)	0.580
skeletal muscle mass index, kg/m^2			
baseline	7.2(1.2)	7.1(1.1)	0.662
6 weeks	7.6(1.2)	7.2(1.2)	0.240
12 weeks	8.4(5.7)	7.5(1.2)	0.716
Fat-free mass index, kg/m^2			
baseline	16.4(1.8)	16.2(1.5)	0.593
6 weeks	16.8(2.1)	16.4(1.7)	0.416
12 weeks	17.8(7.0)	16.7(1.6)	0.886
ASM, kg			
baseline	18.5(4.8)	18.0(4.4)	0.662
6 weeks	19.8(5.1)	18.0(4.7)	0.240
12 weeks	19.3(4.8)	18.8(4.6)	0.716
Leg muscle mass, kg			
baseline	14.5(11.2–17.8)	13.7(11.6–18.1)	0.531
6 weeks	16.1(12.8–19.2)	14.3(11.5–18.7)	0.123
12 weeks	15.3(12.7–19.5)	14.8(12.8–18.9)	0.744
Lean body mass, kg			
baseline	42.0(8.7)	40.9(6.8)	0.497
6 weeks	44.1(9.4)	40.8(7.7)	0.108
12 weeks	46.1(19.7)	41.8(7.6)	0.383

6MWD: 6-min walking distance; 4MGS: 4-metre gait speed test; SPPB: Short Physical Performance Battery; ADL: activities of daily living; MNA-SF: short form mini nutritional assessment; MMSE: Mini-Mental State Examination; GDS-15: geriatric depression scale-15; SF-12: the 12-item Short Form Survey; VFA: Visceral Fat Area; SMI: skeletal muscle index; AMC, Arm Muscle Circumference; ASM, appendicular skeletal muscle mass. a. As for the analysis about primary and secondary outcomes analysis, from baseline to 6 weeks, paired sample t test or wilcoxon signed rank sum test was used to assess whether experimental and control group parameter variation. the similar method was used to assess changes in the indicators from baseline to 12 weeks.

presented in Table 2. The average age in total population was 85 (82, 88) years; among them, control group was 86 (83, 89) years, exercise group was 83 (80, 87) years, and 59 (56.7%) participants were female. During the study, seven people in all groups were eliminated. Therefore, the control and exercise groups included 60 and 37 individuals, respectively. Finally, 69 individuals completed all assessments. Attendance rates were 31 (78%) and 38 (60%) for the exercise and control groups, respectively.

Primary Outcomes

After 12 weeks of intervention, the exercise group showed a significant improvement in SPPB, with a change of 2(0, 3.5)

Table 3. Comparison of differences between groups at baseline, 6 weeks, and 12 weeks

	Control	Exercise	P value[a]				
			Con vs Exe Basline	Con vs con 6weeks	Con vs con 12weeks	Exe vs Exe 6weeks	Exe vs Exe 12weeks
Primary outcomes							
SPPB							
Baseline	6(4–8)	6.5(4–9)					
Change at 6 weeks	0(-5–5)	-4.5(-16.8–6.8)	0.254	0.569	0.003	0.118	0.823
Change at 12 weeks	0(0–6)	2(0–3.5)					
ADL							
Baseline	95(85–100)	90(90–100)					
Change at 6 weeks	5(-12–17)	0(0–4)	0.439	0.571	0.078	1.000	0.022
Change at 12 weeks	0(-1–1.2)	5(0–10)					
Secondary outcomes							
IADL							
Baseline	16(11.8–21.3)	19(14–23)					
Change at 6 weeks	0(-3–5)	-1(-4.5–0)	0.161	0.849	0.001	0.049	0.460
Change at 12 weeks	0.5(-2–4)	2.3(-1–5.5)					
Tinetti							
Baseline	23.5(18–26.3)	25(21–27)					
Change at 6 weeks	-2(-5–1)	-1(-3.75–1)	0.404	0.119	<0.001	0.124	0.590
Change at 12 weeks	0(-3–1)	1.3(0–4.5)					
MNA-SF							
Baseline	13(12–14)	13(12–14)					
Change at 6 weeks	0(-2–1)	0(-1–0.75)	0.529	0.137	1.000	0.815	0.791
Change at 12 weeks	1(0–2)	0(0–1.5)					
FRAIL							
Baseline	2(0–2)	1(0–2)					
Change at 6 weeks	0(0–1)	0(-1–1)	0.077	0.503	0.832	1.000	0.180
Change at 12 weeks	1(0–2)	0(0–1)					
MMSE							
Baseline	26(21.8–29.3)	25(23–28)					
Change at 6 weeks	0(-2–2.5)	1(-0.8–3.8)	0.560	<0.001	0.870	0.076	0.008
Change at 12 weeks	3(0–5.2)	5(2–5)					
GDS-15							
Baseline	3(1–6)	2(1–4)					
Change at 6 weeks	0(-2.5–1)	0(-1–1)	0.204	0.565	0.361	1.000	0.700
Change at 12 weeks	1(0–2)	1(0–3)					
QoL (SF-12)							
Baseline	70.7(20.7)	78.1(22.3)					
Change at 6 weeks	0.1(20.6)	-0.1(21.5)	0.056	0.988	0.104	0.987	0.818
Change at 12 weeks	-5.3(19.6)	-0.8(20.7)					
Grip strength, kg							
Dominant hand							
Baseline	17.7(7.5)	19.6(6.6)					
Change at 6 weeks	1.3(6.6)	-0.8(6.4)	0.251	<0.001	0.676	0.459	0.194
Change at 12 weeks	0.3(4.7)	-1.0(4.4)					
Non dominant hand							
Baseline	14.5(7.9)	16.8(6.4)					
Change at 6 weeks	1.3(7.0)	-1.0(6.6)	0.113	0.188	0.324	0.216	0.010
Change at 12 weeks	-0.9(5.3)	-0.9(4.6)					
6MWD, m							
Baseline	220.0(132.3)	271.3(125.1)					
Change at 6 weeks	-21.22(59.4)	-40.6(94.2)	0.052	0.032	0.005	0.100	0.230
Change at 12 weeks	-26.2(54.5)	1.4(63.6)					
4MGS, m/s							
Baseline	0.7(0.4,1.0)	0.8(0.5,1.0)					
Change at 6 weeks	0(-4.0,2.0)	0(-4.0,2.0)	0.111	0.248	0.005	0.523	0.003
Change at 12 weeks	1.3(0.6,4.0)	0(-4,2.7)					

Table 3 (Continued). Comparison of differences between groups at baseline, 6 weeks, and 12 weeks

	Control	Exercise	P value[a]				
			Con vs Exe Basline	Con vs con 6weeks	Con vs con 12weeks	Exe vs Exe 6weeks	Exe vs Exe 12weeks
Body Composition							
Weight, kg							
Baseline	64.0(10.3)	63.4(10.0)					
Change at 6 weeks	1.0(2.9)	0.2(1.9)	0.794	0.034	0.091	0.216	0.144
Change at 12 weeks	3.2(17.1)	0.5(2.0)					
Body Mass Index, kg/m^2							
Baseline	25.2(3.0)	25.2(3.1)					
Change at 6 weeks	0.5(1.1)	0.3(1.0)	0.583	0.012	0.043	0.146	0.072
Change at 12 weeks	11.1(67.8)	0.3(0.8)					
Total Body Water, L							
Baseline	31.0(6.4)	30.2(5.2)					
Change at 6 weeks	0.5(1.4)	0.1(1.3)	0.503	0.055	0.200	0.927	0.002
Change at 12 weeks	12.7(75.6)	0.7(1.2)					
TBW/FFM, %							
Baseline	73.9(73.8–74.3)	73.9(73.6–74.2)					
Change at 6 weeks	0(-0.2–0.1)	0(-0.1–0.1)	0.458	0.710	0.391	0.678	0.789
Change at 12 weeks	-0.1(-0.3–0.1)	0(-0.2–0.2)					
Fat mass, kg							
Baseline	22.0(6.1)	22.6(6.1)					
Change at 6 weeks	0.4(2.9)	0.1(2.5)	0.652	0.416	0.278	0.840	0.299
Change at 12 weeks	-0.5(2.7)	-0.5(2.6)					
Soft Lean Mass, kg							
Baseline	39.0(33.1–45.8)	39.1(33.2–43.5)					
Change at 6 weeks	0.6(-0.6–1.5)	0.3(-1.2–1.5)	0.511	0.064	0.256	0.887	0.002
Change at 12 weeks	1(-1.1–2.4)	0.9(0.2–2.1)					
Fat-free mass, kg							
Baseline	42.0(8.7)	40.9(6.8)					
Change at 6 weeks	0.6(2.1)	0.1(1.9)	0.495	0.066	0.256	0.831	0.002
Change at 12 weeks	3.7(17.6)	1.0(1.7)					
Percent Body Fat, %							
Baseline	35.1(28.9–40.7)	36.1(30–39.7)					
Change at 6 weeks	-0.1(-1.8–1.8)	-0.3(-1.9–1.6)	0.699	0.967	0.113	0.787	0.104
Change at 12 weeks	-0.3(-4.1–1.2)	-0.5(-2.9–1.1)					
Body Fat Mass, kg							
Baseline	-11.5(5.7)	-12.0(5.7)					
Change at 6 weeks	-0.2(3.1)	-0.1(2.7)	0.637	0.722	0.521	0.820	0.255
Change at 12 weeks	0.3(3.0)	0.5(2.7)					
Bone Mineral Content, kg							
Baseline	2.4(0.5)	2.4(0.3)					
Change at 6 weeks	0.1(0.2)	0.1(0.2)	0.615	0.144	0.188	0.577	0.020
Change at 12 weeks	-12.4(78.3)	0.1(0.2)					
Arm Circumference, cm							
Baseline	28.0(2.5)	28.3(2.6)					
Change at 6 weeks	-0.1(1.3)	-0.2(1.2)	0.642	0.756	0.100	0.486	0.129
Change at 12 weeks	6.8(46.3)	-0.3(1.3)					
AMC, cm							
Baseline	23.4(1.8)	23.6(2.1)					
Change at 6 weeks	0.1(1.3)	0.2(1.2)	0.512	0.512	0.025	0.326	0.900
Change at 12 weeks	2.3(18.1)	-0.1(1.2)					
Waist circumference, cm							
Baseline	76.0(9.5)	77.1(10.1)					
Change at 6 weeks	-1.3(5.5)	-1.8(4.7)	0.572	0.337	0.007	1.000	0.059
Change at 12 weeks	-3.2(7.0)	-3.5(5.9)					

Table 3 (Continued). Comparison of differences between groups at baseline, 6 weeks, and 12 weeks

	Control	Exercise	P value[a]				
			Con vs Exe Basline	Con vs con 6weeks	Con vs con 12weeks	Exe vs Exe 6weeks	Exe vs Exe 12weeks
VFA, cm²							
Baseline	105.2(34.8)	107.2(35.4)					
Change at 6 weeks	0.1(1.3)	0.2(1.2)	0.779	0.142	0.004	0.252	0.230
Change at 12 weeks	-11.6(23.5)	-11.0(21.1)					
SMI, kg/m²							
Baseline	7.2(1.2)	7.1(1.1)					
Change at 6 weeks	0.3(0.4)	0.1(0.4)	0.662	0.001	0.037	0.719	<0.001
Change at 12 weeks	1.2(5.4)	0.3(0.5)					
Fat-free mass index, kg/m²							
Baseline	16.4(1.8)	16.2(1.5)					
Change at 6 weeks	0.3(0.4)	0.1(0.8)	0.593	0.070	0.256	0.977	0.004
Change at 12 weeks	1.2(5.7)	0.4(0.7)					
ASM, kg							
Baseline	18.5(4.8)	18.0(4.4)					
Change at 6 weeks	0.6(1.0)	0.2(1.1)	0.662	0.001	0.200	0.447	<.001
Change at 12 weeks	0.6(1.9)	0.8(1.2)					
Leg muscle mass, kg							
Baseline	14.5(11.2–17.8)	13.7(11.6–18.1)					
Change at 6 weeks	0.4(-0.3–1.2)	0.1(-0.4–0.7)	0.531	0.010	0.337	0.596	<0.001
Change at 12 weeks	0.2(-0.6–1.9)	0.7(-0.1–2.4)					
Lean body mass, kg							
Baseline	42.0(8.7)	40.9(6.8)					
Change at 6 weeks	0.6(2.1)	0.1(1.9)	0.497	0.066	0.337	0.853	0.002
Change at 12 weeks	3.7(17.6)	1.0(1.7)					

VFA, Visceral Fat Area;SMI: skeletal muscle index; AMC, Arm Muscle Circumference; ASM, appendicular skeletal muscle mass. a. As for the analysis about difference between groups at 6 weeks or 12 weeks, the two-independent sample t-test or the Mann–Whitney test was used.

(P< 0.001), when compared to the usual care. In contrast, SPPB remained stable in the control group, the average change was 0(0–6) (P= 0.569) (Table 2). The detailed distribution of SPPB is presented in Figure 2. The subgroup analysis of SPPB was used to assess the efficiency of this clinical trial; we discovered that despite low(0–6 points), intermediate (7–9 points), or high (10–12 points) SPPB, differences between groups at 12 weeks were significant at post-intervention at 12 weeks (P= 0.001) (Supplementary Table 1). Similar tendencies were observed with ADL (Table 2, Supplementary Table 2). Overall, we believed that multicomponent exercise was an effective method of reversing the functional decline in older adults.

Secondary Outcomes

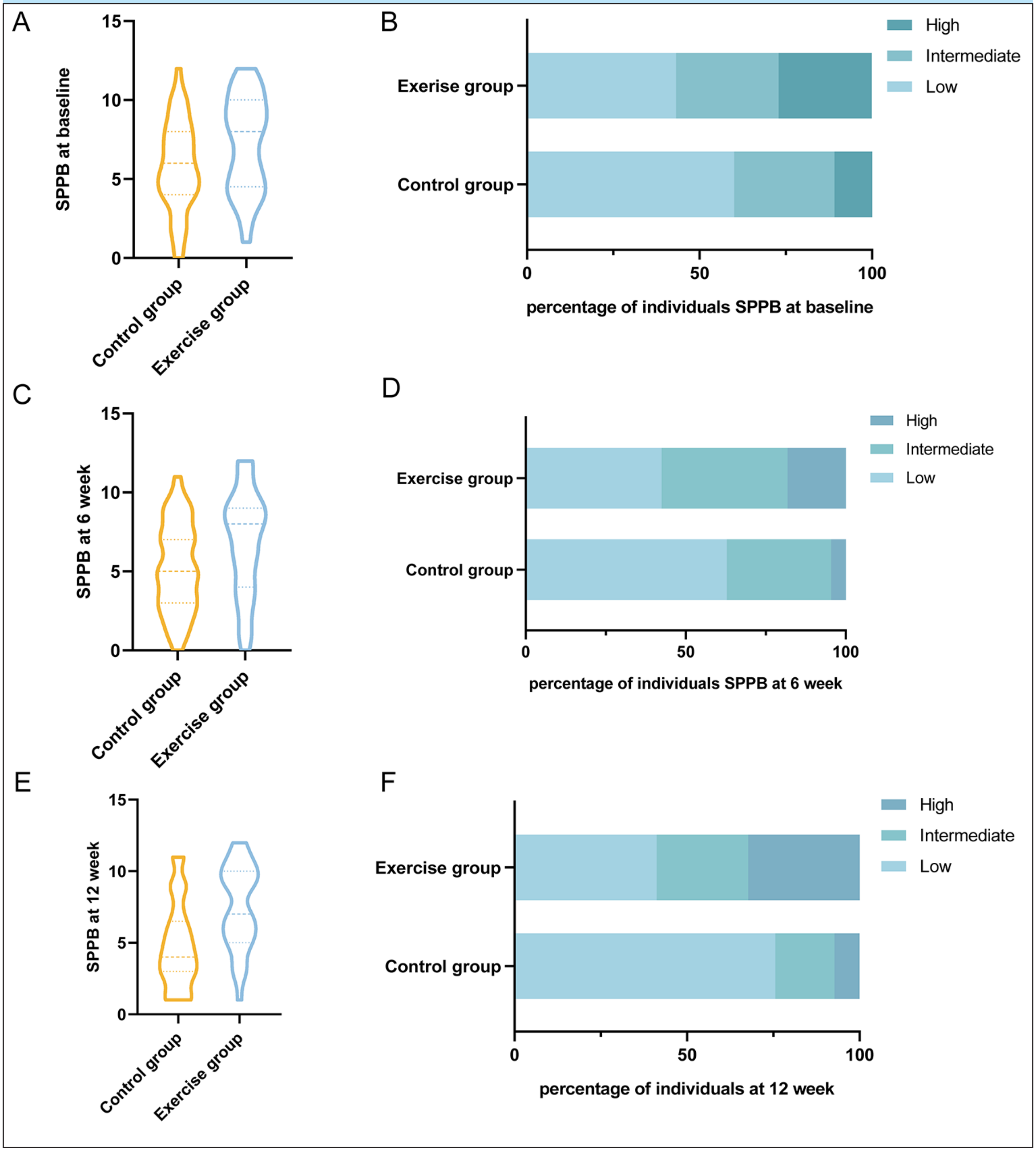
Cognitive Function, Grip Strength, Balance, Gait, and Quality of Life

Regarding the secondary outcomes, exercise intervention was likely to be valid in enhancing the 4MGS after 12 weeks; the exercise group had an average time of 4 seconds (95% CI [3,6], P= 0.001) compared with the control group, and the time remained stable; additionally, the control group average increased 3 seconds (95% CI [3, 6.2], P= 0.005). Tinetti score increased by 1.3 points (95% CI [0, 4.5], P< 0.001) in the exercise group, with a relative increase of 5% after 12 weeks; the non-exercise group declined slightly or remained stable compared with the baseline (6 weeks, -2 (-5,1), P= 0.119; 12 weeks, 0 (-3,1), P< 0.001) (Tables 2 and 3). Similarly, 6MWD was a positive result for support exercise intervention; 12 weeks follow-up showed 299.1±120.2 m and 184.2±101.7 m for the experimental and control groups, respectively. The difference between groups was significant. However, grip strength, MMSE, and GDS-15 did not change between groups (Table 2).

Change in Body Composition

Table 3 presents the difference between groups regarding body composition after 12 weeks. Although no significant differences were found in parameters between groups, some indicators involved muscle strength still improved after exercise when compared to their baseline measurements. Leg muscle mass improved in the post-exercise (13.7–14.8 kg), with a change of 0.7 (-0.1, 2.4) kg (P< 0.001); leg muscle mass remained constant in the control group (14.5–15.3 kg), with a change of 0.2 (-0.6, 1.0) kg (P= 0.337). Similar results were found in Appendicular skeletal muscle mass, soft lean mass and fat-free mass. Fat mass, arm circumference, arm muscle circumference, waist circumference, and visceral fat area decreased in the exercise group. The analysis was objective and further confirmed that exercise could improve muscle mass for older adults. More analysis results were attached in Supplementary Document 2.

Figure 2. The detailed distribution of SPPB in the control and exercise groups



Adverse Events

Supplementary Table 3 recorded the intervention-related adverse events. Adverse events were defined as falls, infections, hospitalization, and death during the study period. The total number of adverse events was three in the control group (one person fell, one was hospitalized, and one died). The exercise group had three adverse events (one person fell, and two were hospitalized). No obvious difference existed between the two groups. The result indicated that exercise among older adults might be a safe way according to the 12 weeks follow-up.

Discussion

The MIFDCE trial describes that an older adults consensus-based multicomponent intervention with low-medium intensity could provide a significant benefit during a short time, which could reverse older adults' functional decline, keep a good balance and enhance muscle strength. Overall, we extend new evidence of multicomponent exercise intervention on functional decline in Chinese older adults.

Few RCTs have assessed the effects of exercise intervention on functional outcomes in older adults. Vivifrail was one of the positive programs that classified elderly individuals into different function statuses using SPPB; it found that 3-month personalized training could decrease the risk of falls and improve cognitive function, muscle function, and depression (18). Jay et al demonstrated that a multicomponent home-based physical therapy intervention did not result in a statistically significant improvement in walk distance after a 16-week intervention by recruiting elderly adults with hip fractures (33). Martínez-Velilla et al showed that a 5-day multicomponent exercise intervention was safe and effective in reversing the functional decline associated with acute hospitalization in very older patients (24). Recently, evidence has demonstrated that a 12-week multicomponent exercise program can improve frailty among community-dwelling Chinese older adults (34). In contrast to previous studies, we discovered a significant improvement between groups in physical status, balance, frailty, gait velocity, and quality of life. Similar falls outcome, MMSE, and body composition were found between groups. The explanation may result from the heterogeneity of response and the difference between the inclusion group.

As for body composition measurements, we choose using MF-BIA, because of its convenience and acceptance. Our research suggested that 12-week multicomponent exercises between older adults could benefit in muscle mass, such as improvement in soft lean mass, fat-free mass, skeletal muscle index, fat-free mass index, leg muscle mass, and lean body mass. In addition, bone mineral content raised and visceral fat area reduced in the exercise program. These result indicated multicomponent exercise in short time is a promising strategy to preserve physical function. However, future studies are warranted to demonstrate its long term effects among Chinese older adults, such as prevention and treatment of disability, sarcopenia, gait instability, and falls.

To identify functional decline and explore the effectiveness of the intervention at an early stage, facilitate unified management, and improve the quality control level, the nursing home was our first consideration. However, additional occasions, such as home, hospital, and community-dwelling, should still emphasize and explore the information related to elderly adults. The intervention benefit was not obvious at 6 weeks and became apparent at 12 weeks, indicating that a longer follow-up period is required.

The strengths of this study are as follows: first, application exercise intervention individually - generally, the training time, style, and frequency were based on older adults' status. Rehabilitation by biking or walking was common practice; when older adults were trained, one or two nursing staff and a physical therapist would supervise, instruct, and ensure the appropriate exercise intensity. Meanwhile, medical professionals in the geriatrics department regularly instructed participants to recognize potential risks. In addition, the assessment tool was designed specially to collect data during different times, and it is convenient to deal with data and reduce errors. The evaluator was blinded to the group allocation, and it could reduce the bias of evaluation results to some extent.

Our study had some limitations. First, many occasions were strictly prohibited because of the COVID-19 outbreak, and unpredictable individuals were excluded from the research period. To some extent, it was limited to enrolling more individuals. Second, the included individuals lived in the same circumstance; people who were categorized into the control group can exercise based on the circumstance effect. Third, even though we arranged all participants with similar clothes and evaluated timepoint, season changes inevitably influenced the analysis of body composition, such as weight and body mass index.

Conclusions

The multicomponent exercise intervention following vivifrail recommendations is an effective method for older adults with functional decline, as it can reverse the functional decline and improve gait, balance, and muscle strength. Additionally, it widens vivifrail research and provides some guidance for Chinese medical professionals working in the field of geriatrics; 12-week multicomponent exercise between all population might be a promising method to improve physical function.

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Conflicts of interest: None declared.

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