

Effectiveness of a group functional power training program for frail older adults implemented through neighbourhood senior centres – a randomised controlled study

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Abstract

Background

Several trials have demonstrated the efficacy of resistance training to reduce frailty and improve function of older adults. To narrow the research-practice gap, we designed and evaluated the implementation of a community-delivered group-based functional power training (FPT) program for frail older adults within their neighbourhoods.

Methods

Two-arm, multicentre assessor-blind stratified randomised controlled trial at four local senior activity centres. Older adults ($n = 61$) with low handgrip strength (HGS) were randomised to intervention (IG) or control (CG) group. The IG underwent the FPT program (power and balance exercises using simple equipments) delivered by a community provider. The 12-week program comprised 2×60 mins sessions/wk. CG continued usual activities at the centres. Functional performance (SPPB and TUG), HGS, knee extensor strength (KES), and frailty status were assessed at baseline and 3-month. Program implementation was evaluated using RE-AIM framework.

Results

The program was halted due to Coronavirus Disease 2019 related suspension of senior centre activities. Results are reported from four centres ($n = 61$), which completed the program. IG showed significant improvement of moderate effect sizes in frailty status (0.36 points, 95CI [0.09, 0.64], $p = 0.011$) and SPPB (0.51 points, 95CI [0.13, 0.89], $p = 0.010$). IG improvement in TUG (0.57 s, 95CI [-0.07, 1.20], $p = 0.080$) did not achieve significance and there were no effects for HGS and KES. Only SPPB showed greater improvement in IG than CG ($p = 0.047$). The community program exhibited good reach, effectiveness, adoption, and implementation.

Conclusions

FPT is superior to regular activities at local senior centres in improving physical function and can be successfully implemented for frail older adults in their neighbourhoods.

Trial registration:

ClinicalTrials.gov, NCT04438876. Registered 19 June 2020 – Retrospectively registered, <https://clinicaltrials.gov/ct2/show/NCT04438876?term=NCT04438876>

Introduction

Community-dwelling older adults are prone to developing frailty (1). Frailty has been defined as “a clinical state in which there is an increased in an individual’s vulnerability for developing an increased dependency and/or mortality when exposed to a stressor” (2). It can occur before 60 years of age and the onset escalates in those aged 70 years and older (3). Frailty is more common in persons with lower education and/or socio-economic status (4). Furthermore, physically frail individuals with low socio-economic status and social support are more prone to suffer functional disability (5).

Frailty is not a contraindication to exercise but a reason to prescribe it. Frailty can be delayed or reversed through interventions where physical training is a key component, especially during the pre-frail stage (6–8). There is wide consensus for pre-frail or frail older people to be offered a physical activity program with a progressive, resistance training component (9, 10).

Resistance training engages low-velocity contractions at 50–80% of maximal strength. Power training is characterised by performing the concentric phase at high velocity (as far as possible) with a slow eccentric phase to achieve the greatest benefit of muscular power and strength. Power training is effective and has emerged as an alternative modality of resistance training to preserve function of older persons to perform activities of daily living that often require quick, forceful motions (11). Randomised controlled trials have demonstrated that high velocity resistance training could improve physical function among pre-frail (12) and frail individuals (13). Given the high local prevalence of pre-frailty (45%) and frailty (5%) in community-dwelling older adults (4), it is imperative for research efforts to move beyond laboratory-based efficacy trials to evaluate effectiveness in real-world settings, with a focus on implementation and real-world partnerships.

Effective interventions in research settings are often not successfully translated to practice due to poor external validity (14). For example, the requirement of specialised equipment and facility in the aforementioned power training exercise interventions (11–13) can limit the translation of these programs in community settings that often do not have access to such facilities and equipments. To bridge such research-practice gap, efficacy of interventions need to be examined in targeted population settings to better understand the enablers and challenges of the intervention in actual practice (15).

We had previously shown the feasibility and potential of a small group functional power training (FPT) program using bodyweight, resistance bands and chairs for frail older adults at a local senior activity centre (16). However, this finding needs to be replicated in a larger study at multiple sites to ascertain the effectiveness of the intervention for wider translation. Therefore, the purpose of this study was to examine the effectiveness and evaluate the implementation of an FPT exercise program for pre-frail and frail community-dwelling older adults through local senior activity centres (https://www.healthhub.sg/a-z/medical-and-care-facilities/8/senior_activity_centre). These centres are located at ground level of residential apartments of public housing and are accessible to older adults with poorer socio-economic status and low social support. Fried frailty criteria was adopted (17), with muscle weakness as an inclusion criteria. It was hypothesised that the program implemented in the local residential community

would be effective to improve functional performance and reduce frailty for individuals with low muscle strength.

Methods

Study design and participants

A two-arm, multicentre assessor-blind stratified randomised controlled trial among pre-frail and frail community-dwelling older adults was conducted between March 2019 and February 2020 in four senior activity centres located within the residential estates in Singapore (ClinicalTrials.gov registration NCT04438876). To be eligible for the study, participants had to (a) be aged 55 years and older, (b) have low muscle strength, (c) ambulate without human assistance and have no other physical limitations to participation and adherence to exercise, and (d) be able to understand basic instructions. Low muscle strength was defined as handgrip strength (HGS) less than 26kg and 18kg in men and women respectively according to the Asian Working Group for Sarcopenia (AWGS) 2014 consensus (18). Participants were excluded if they (a) were currently enrolled in another study, (b) had any acute musculoskeletal injury or other contraindication to exercise, (c) were unable to participate in the full duration of the study, (d) were unwilling to participate if not assigned to the intervention group, and (e) were deemed not suitable to participate in exercise by a medical doctor. After initial eligibility screening by senior activity centre staff or research coordinator, a doctor examined each subject for medical clearance prior to exercise participation and excluded subjects who did not meet the medical criteria. Participants were then randomly allocated to either the control group (CG) or the intervention group (IG) with a 1:1 allocation ratio based on computerised block randomisation, stratified by their HGS. Ethical approval was obtained from the National Healthcare Group DSRB (2018/00593). All participants signed informed consent prior to participation in the study.

Intervention group

The IG underwent a 12-week structured FPT program, conducted by an exercise-science qualified trainer from a community service provider (Empower Ageing Limited; Singapore; <http://www.empower.org.sg>). Hourly sessions were held twice weekly at local senior activity centres. The exercise intervention comprised progressive power and balance exercises that targeted both upper and lower body muscles. The list of specific exercises for each respective session is presented in Table 1 and detailed elsewhere (19). Participants performed three sets of each power exercise, with 10-20 repetitions per set, and 12-60 repetitions per set for balance exercises. For the power training, body weight and/or resistance bands were used as resistance and participants were instructed to move as fast as they can during the concentric phase and slowly during the eccentric phase of the exercise movements. To ensure safety, blood pressure of participants was measured before and after each session with an automated sphygmomanometer (Omron HEM-7121, Omron, Kyoto, Japan). Arterial blood oxygen saturation and heart rate were measured at start, mid-point, and end of each exercise session with pulse oximetry (MD300C63, ChoiceMMed, Bristol, Pennsylvania, USA) to monitor exercise intensity levels. Participant

with either (a) blood oxygen levels below 95% saturation; (b) high resting heart rate (≥ 90 beats per minute); (c) abnormal resting blood pressure (systolic blood pressure ≥ 130 mmHg or diastolic blood pressure ≥ 80 mmHg); (d) giddiness or (e) any form of discomfort did not initiate or continue with training session. Participants also rated their perceived exertion after each exercise set and were encouraged to alert the trainer if they felt any discomfort during the training. We monitored and recorded adverse events throughout the intervention program. In addition, participants also received monthly health education talks on nutrition and cognition, conducted by staff from Geriatric Education and Research Institute.

Control group

Participants in the CG could continue with the available exercise program at the respective senior activity centres. Senior activity centres typically had chairs arranged for participants who followed after daily video of stretching, aerobic and balance exercises produced by the Health Promotion Board (20). Participants then had snacks and socialise over group games provided at the centres. The CG was given an exercise manual with the list of exercises in the intervention programme. CG participants were also encouraged to attend the health education talks. Adherence of CG participants to centre activity was not monitored.

Measurements

Objective physical outcome assessments were conducted at baseline and 3-month follow-up by assessors who were blinded to participants' group allocation.

Physical function assessment

Physical function assessments included HGS (21), knee extensor strength (KES) (22), timed up and go (TUG) (23), and the Short Physical Performance Battery (SPPB) (24). HGS was measured using the Jamar Plus+ Digital Hand Dynamometer (Patterson Medical, Evergreen Boulevard, Cedarburg, USA). KES was measured using a spring gauge strapped 10 cm above the ankle joint, and the highest of four readings (two trials per leg) recorded. For TUG, participants stood up from a chair, walked three metres and back, then sat back down. The test was performed twice, and the average time recorded. SPPB comprised three components: balance, gait speed and repeated chair stands. A composite score of 0–12 points was calculated (25), whereby higher scores indicate better functional performance.

Frailty status assessment

The frailty status of participants was assessed using Cardiovascular Health Study (CHS) Frailty Criteria, which characterises frailty based on five components: weakness, unintentional weight loss, slowness, exhaustion and low physical activity (17). Weakness was identified according the AWGS 2014 criteria as HGS less than 26kg and 18kg for men and women respectively (18). Unintentional weight loss was defined by either BMI less than 18.5kg/m² or self-reported unintentional weight loss of at least 4.5 kg (10 pounds) in the last six months. Slowness was determined by 6 m walking speed with specified cut-offs

based on gender and height. Exhaustion was self-reported through a 3-item questionnaire adapted from the SF-12 survey (26). The Longitudinal Aging Study of Amsterdam Physical Activity Questionnaire was administered to assess participants' physical activity levels (27). Low physical activity was defined as energy expenditure less than 383 kcal/week and 270 kcal/week for men and women respectively. One point was given for presence of each component, and frailty status classification was defined as robust (0), pre-frail (1-2), and frail (3-5) (17).

Other measures

All participants answered a questionnaire on their baseline demographic information, smoking history, medical conditions, and comorbidities. Anthropometric measurements such as height, weight, body mass index (BMI) and weight circumference were taken during the baseline assessment session. The Mini-Mental State Examination was administered to assess cognitive function in participants. It was scored out of 30, with higher scores indicating better cognitive function (28).

Evaluation of program implementation

The implementation of the FPT intervention was evaluated using the RE-AIM framework (29), a model designed to appraise public health interventions. Present study employed four of the five dimensions specified in the framework: reach, effectiveness, adoption, and implementation. First, "reach" was calculated as the percentage of eligible participants who enrolled in the study. Second, "effectiveness" was assessed based on objective outcome assessments stated above, program attrition rate and participant experience. Participant experience was reported post-intervention in the IG only using a 9-item questionnaire administered by the research team. Participants responded by indicating the extent of agreement with the questionnaire items on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Third, "adoption" was determined as proportion of senior activity centres approached that agreed to implement the intervention. Fourth, "implementation" was assessed based on fidelity of intervention delivery at both provider and participant levels. At the provider-level, the extent of deviation between the trainer's delivery and the intended exercise program was recorded by a research coordinator who observed every training session and recorded attendance. At the participant-level, implementation was evaluated by program attendance rate and proportion of the exercise program completed by participants. The intervention was deemed to have good adherence if a mean attendance rate of at least 80% was achieved. The dimension of "maintenance" was excluded as the present study was not designed to determine the longer term effects of the intervention. We monitored and recorded adverse events throughout the course of the program.

Sample size calculation

Based on a priori power analysis (G*Power 3.1.9.3) using a power of 0.90 and error probability of 0.05, a sample size of 50 participants is required for each group to detect an assumed 20% difference in SPPB between IG and CG. In addition, with an assumption of 15% dropout rate, a sample size of 120 participants was initially targeted.

Statistical analysis

Independent samples t-tests and chi-squared tests were employed to examine differences in baseline measures between CG and IG for continuous and categorical variables respectively. Levene's test was conducted to ensure no violation of equal variance assumption. Linear mixed-effect modelling was performed to examine changes in physical function and frailty status between baseline and 3-month follow-up across both groups. Primary independent variables in each model included treatment groups, time, as well as group x time interaction. The models also included random intercepts to account for correlations between repeated measures for each participant. Data analyses were performed based on the intention-to-treat (ITT) principle (30), and the maximum likelihood method was employed to impute missing values. Post-hoc pairwise comparisons were conducted to examine the main effect of time in respective groups. Statistical significance level was set at 0.05, and all analyses were performed using Statistical Package for the Social Science (SPSS Version 20.0, Chicago, IL). Threshold values were selected as standardised effect size (ES) of mean differences and deemed as 0.2, 0.6, 1.2 and 2.0 for small, moderate, large and very large, respectively (31).

Results

Figure 1 presents the study flow from screening to analyses. A total of 110 participants were screened for eligibility through partnership with four senior activity centres in this study, of which 61 were randomised to the CG (n = 31) and IG (n = 30). In partnership with a fifth senior activity centre, another 50 subjects were screened, 33 completed pre-participation medical examination and 31 eligible signed informed consent on 4 Feb 2020. The first case of Coronavirus Disease 2019 (COVID-19) in Singapore was confirmed on 23 January 2020. We could not proceed with the study after health authority mandated suspension of all group senior activities with effect from 8 Feb 2020 and decision was made in May 2020 (with suspension still in force) to close the study and perform analyses on the 61 participants from the four centres. Four participants in the CG and seven participants in the IG did not complete the study. Table 2 presents the descriptive characteristics of both CG and IG. No significant differences were found in baseline measures between the two groups.

Effectiveness of program intervention

The outcome measures at baseline and 3-month follow-up are presented in Table 3 and Figure 2. No significant differences were found in all outcome measures between CG and IG at baseline. Significant interaction between group and time was found for SPPB [$F(1, 50.250) = 4.134, p = 0.047$]. However, no significant interaction between group and time was found for frailty status [$F(1, 55.406) = 0.216, p = 0.644$], HGS [$F(1, 51.857) = 0.303, p = 0.584$], KES [$F(1, 52.619) = 0.959, p = 0.332$], TUG [$F(1, 50.935) = 2.450, p = 0.124$]. Among the components of SPPB, group x time interaction effect was found only for repeated chair stands [$F(1, 52.043) = 7.174, p = 0.010$].

Post-hoc pairwise comparisons found significant changes in outcomes measures between baseline and 3-month follow-up in both groups. For the IG, post-program frailty status significantly improved by 0.36

points, 0.51 ES, 95% confidence interval (95CI) [0.09, 0.64], $p = 0.011$. Similarly, SPPB scores improved by 0.51 points, 0.58 ES, 95CI [0.13, 0.89], $p = 0.010$. Among the SPPB components, only repeated chair stand component was found to significantly improve by 0.41 points, 0.85 ES, 95CI [0.153, 0.667], $p = 0.002$. Improvement of 0.57s in TUG performance did not achieve statistical significance, 0.25 ES, 95CI [-0.07, 1.20], $p = 0.080$. No significant differences were found for HGS and KES. For the CG, significant improvement between baseline and 3-month follow-up was found in frailty status by 0.28 points, 0.40 ES, 95CI [0.02, 0.53], $p = 0.035$; and HGS by 1.19kg, 0.28 ES, 95CI [0.20, 2.18], $p = 0.020$. No significant changes were found in KES, TUG and SPPB performance for the CG.

Program implementation outcomes

Reach

160 older adults were assessed for eligibility, of which 34 (21.3%) did not meet the study's inclusion criteria. Out of the remaining 126 (78.7%), 33 (26.2%) were deemed not suitable to participate in the intervention by a medical doctor. Among the 93 eligible individuals, one (1.1%) declined to participate. Therefore, 98.9% of eligible individuals agreed to participate in the FPT training program. However, 31 participants could not start the intervention due to the study being disrupted by COVID-19.

Effectiveness

The effectiveness of the intervention on objective physical outcome measures was reported above. Among the 27 participants who started the intervention, four (14.8%) did not complete the exercise program. One withdrew from the study due to personal reason and one dropped out because of medical reason unrelated to the study. There was no other adverse event during the program. Two participants reported that the exercise intervention was too challenging and dropped out on the fourth and fifteenth session, with attendance rate of 25% and 57.1% respectively. The participant experience questionnaire was administered to 23 participants who completed the intervention. All participants agreed that the intervention was positive in terms of organisation, engagement and relevance to daily activities (Table 4). On average, participants also reported that they benefited from the intervention and felt happier. In addition, all participants indicated that they would participate in such exercise program in the future. Only one participant disagreed that the intervention improved the social interaction among participants.

Adoption

100% adoption rate was achieved at the setting level. All seven senior activity centres with schedule availability that were approached agreed to participate in the study. However, the intervention was not conducted at two centres due to insufficient number of participants who met the study's eligibility criteria.

Implementation

At the provider-level, among the total of 96 sessions conducted across four senior activity centres, two (2.1%) sessions had minor adaptations by the trainer. One session reduced the number of repetitions for

one set of power component exercise and the other session prescribed different balance exercises of lower difficulty. At the participant-level, the mean attendance rate attained was 87.5% among those who completed the program. Most (87%) participants achieved an attendance rate of at least 80%, and 17.4% (n=4) of the participants completed all the program sessions. On average, participants were found to complete 95.7% of the prescribed exercise program in the sessions they attended. Reasons for failing to complete the program include being late, feeling unwell, and leaving the session early. Seven (30.4%) participants achieved 100% participant fidelity rate.

Discussion

The present study evaluated the effectiveness and implementation of a 12-week FPT program for pre-frail and frail older adults with low grip strength at their neighbourhood senior activity centres. The FPT program significantly reduced frailty and improved physical function performance of the participants. Evaluation of the intervention indicated good reach, effectiveness, adoption, and implementation outcomes. In support of our hypothesis, our study showed that an effective frailty reduction FPT program can be successfully implemented at local senior activity centres by local providers.

Performance of daily activities and life-threatening risks (e.g. falls) are more closely related to muscle power than strength in older adults (32). Structured muscle power training involving specialised equipment has been reported to be beneficial in improving physical function and muscle strength among frail individuals (12, 13). The results of the present study support such mode of exercise prescription and provided important evidence on translation by showing that a FPT program implemented in real-world settings can reduce frailty and improve training specific functional performance. Our result strengthens available evidence that exercise interventions using simple equipment could be effective in reducing frailty (16, 33). It is an important finding that such an exercise intervention (34) can be implemented in local community settings as an effective option to complement what is currently available.

The significant interaction between group and time found for SPPB in present study suggests that the intervention program was better in improving physical function as compared to the usual exercise program offered at community senior activity centres. Indeed, participants in the IG were found to exhibit small-moderate improvement in SPPB scores after the intervention. In contrast, SPPB scores of the CG did not change. The mean increase of 0.51 points in SPPB scores of IG met the recommended cut-off of 0.5 points in representing a small and clinically meaningful change in physical function among older adults (35). Examination of individual components revealed that the improvement in SPPB scores resulted specifically from improvement in repeated chair stand performance. This training specific improvement is not surprising. Previous studies reported that high velocity resistance training is effective in increasing repeated chair rise ability among older adults (36, 37). In addition, the use of bodyweight as resistance in exercise programs to simulate daily living activities has been recommended to enhance functional capacity (38). Hence, this interaction effect is likely attributed to the emphasis on high velocity muscle contraction and specificity of the program prescribed exercises to daily activities.

While the program intervention improved frailty status and marginally improved TUG, the changes did not differ significantly from that in the CG. Given the small effect size, the lack of significance could be attributed to a low statistical power achieved. This was due to an unexpected and mandatory suspension of senior centre activities and the study due to COVID-19, resulting in a smaller sample. Nevertheless, the results showed that the intervention programme was at least as equally effective as the current exercise program offered at the senior activity centres. In contrast to functional performance, the FPT program did not elicit significant improvements in both HGS and KES. This differs from previous report of increase in muscle strength among frail older adults with muscle power training (13). The conflicting results may be attributed to the difference in intervention protocols between the studies. As the FPT program was designed to improve function performance, the exercise intensity may be inadequate to elicit significant strength gains. Similar results were reported in other studies of functional exercise interventions (34, 39).

Besides demonstrating effectiveness in physical outcomes, the results also showed that the FPT program is a feasible in terms of reach, participation of frail older persons, participation, adoption and implementation by local providers in actual community settings based on the RE-AIM framework (29). The intervention exhibited good reach with 98.4% of eligible individuals opting to join the study. Despite the drop-out rate of 14.8%, participants who completed the intervention showed good adherence with mean attendance rate of 87.5%. Post-intervention questionnaire results also indicated that participants generally had positive experience of the community-delivered training program. In addition, the intervention showed good fidelity at both provider- and participant-level with minor but necessary deviation from the intended protocol. This showed that the exercise program was suitable for the targeted vulnerable population. Furthermore, the intervention had excellent adoption rate of 100% from the community senior activity centres approached. However, the findings also highlighted a potential challenge in which some centres have inadequate number of eligible participants to implement the program. Some spouses of participants wanted to enrolled but did not meet the muscle weakness criteria. It is possible that these participants be involved either as volunteers or participants. Collectively, these outcomes could better inform relevant stakeholders in the delivery of such exercise programs in the community. Senior activity centres receive government subsidy for their programs and operations and depending on their socio-economic status, members either pay a small fee or join for free. This study provides evidence that such a program to maintain function in frail participants warrants additional government funding. As centres do not have the appropriate manpower to conduct such a program, this service can be contracted to a local provider for cost sharing between centres. Due to COVID-19 related suspension of group activities at the senior centres, the provider has worked with some centres to offer FPT program via Facebook livestream (40). A strategy to bridge the digital divide of some older people has been to pair them up with others in their family or neighbours who can help with digital access and engagement with the live online training program. While not specifically measured in our study, the social engagement has been shown to be an important aspect of adherence to group training (8).

This study demonstrated that a community-delivered FPT program can be effective and feasible to reduce frailty and improve function in vulnerable older persons. However, it is important to acknowledge some limitations associated with the study. First, the study population consists of community-dwelling

frail older adults and may not generalise to persons who are not frail nor frail persons in the hospitals or nursing homes. Second, due to the Covid-19 disruption of the study, we were unable to compare any post-program maintenance effects between the two groups. Given that physical function improvements induced by power training were reported to retain longer as compared to strength training (12), the longer term effects of the FPT program warrant further study.

In conclusion, this study showed that community-delivered FPT program was an effective and feasible intervention for frail older adults in their neighbourhoods. The intervention was superior to exercise program offered at local senior activity centres in improving functional performance. Improvements in frailty status and TUG were also observed. Positive implementation outcomes suggest that the program is promising for wider community translation.

Abbreviations

95CI

95% confidence interval

AWGS

Asian working group for Sarcopenia

BMI

Body mass index

CG

Control group

CHS

Cardiovascular health study

COVID-19

Coronavirus disease 2019

CVD

Cardiovascular disease

EE

Energy expenditure

ES

Effect size

FPT

Functional power training

HGS

Handgrip strength

IG

Intervention group

KES

Knee extensor strength

MMSE

Mini-mental state examination
SPPB
Short physical performance battery
TUG
Timed up and go
WC
Waist circumference

Declarations

Ethics approval and consent to participate

This study received ethics approval from National Healthcare Group DSRB (2018/00593). All participants provided written informed consent prior to participation in the study.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

SLW, WTS and DHMN contributed to the study concept and design. NXT, SLW, WTS, DHMN, BWJP and LKL contributed to participant recruitment and data collection. NXT and WTS performed data analysis. NXT, SLW, WTS, TPN, DHMN, BWJP and LKL contributed to the interpretation of results. NXT, SLW, WTS and TPN wrote the manuscript. SLW and TPN contributed to the critical revision of the manuscript for important intellectual content. All authors have critically read, reviewed, and approved the final manuscript.

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References

1. Ofori-Asenso R, Chin KL, Mazidi M, Zomer E, Ilomaki J, Zullo AR, et al. Global incidence of frailty and prefrailty among community-dwelling older adults: a systematic review and meta-analysis. *JAMA Netw Open*. 2019;2(8):1–18.
2. Morley JE, Vellas B, Van Kan GA, Anker SD, Bauer JM, Bernabei R, et al. Frailty consensus: a call to action. *J Am Med Dir Assoc*. 2013;14(6):392–7.
3. Hoogendijk EO, Rockwood K, Theou O, Armstrong JJ, Onwuteaka-Philipsen BD, Deeg DJ, et al. Tracking changes in frailty throughout later life: results from a 17-year longitudinal study in the Netherlands. *Age Ageing*. 2018;47(5):727–33.
4. Wei K, Nyunt MSZ, Gao Q, Wee SL, Ng T-P. Frailty and malnutrition: related and distinct syndrome prevalence and association among community-dwelling older adults: Singapore longitudinal ageing studies. *J Am Med Dir Assoc*. 2017;18(12):1019–28.
5. Teo N, Gao Q, Nyunt MSZ, Wee SL, Ng T-P. Social frailty and functional disability: Findings from the Singapore Longitudinal Ageing Studies. *J Am Med Dir Assoc*. 2017;18(7):637. e13- e19.
6. Travers J, Romero-Ortuno R, Bailey J, Cooney M-T. Delaying and reversing frailty: a systematic review of primary care interventions. *Brit J Gen Pract*. 2019;69(678):e61-e9.
7. Apóstolo J, Cooke R, Bobrowicz-Campos E, Santana S, Marcucci M, Cano A, et al. Effectiveness of interventions to prevent pre-frailty and frailty progression in older adults: a systematic review. *JBIC Database Syst Rev Implement Rep*. 2018;16(1):140.
8. Liu X, Ng DH-M, Seah JW-T, Munro YL, Wee S-L. Update on Interventions to Prevent or Reduce Frailty in Community-Dwelling Older Adults: a Scoping Review and Community Translation. *Curr Geriatr Rep*. 2019;8(2):72–86.
9. Dent E, Morley J, Cruz-Jentoft A, Woodhouse L, Rodriguez-Manas L, Fried L, et al. Physical frailty: ICFSR international clinical practice guidelines for identification and management. *J Nutr Health Aging*. 2019;23(9):771–87.
10. Fragala MS, Cadore EL, Dorgo S, Izquierdo M, Kraemer WJ, Peterson MD, et al. Resistance training for older adults: position statement from the national strength and conditioning association. *J Strength Cond Res*. 2019;33(8):2019–52.
11. Ramírez-Campillo R, Castillo A, Carlos I, Campos-Jara C, Andrade DC, Álvarez C, et al. High-speed resistance training is more effective than low-speed resistance training to increase functional

- capacity and muscle performance in older women. *Exp Gerontol.* 2014;58:51–7.
12. Zech A, Drey M, Freiberger E, Hentschke C, Bauer JM, Sieber CC, et al. Residual effects of muscle strength and muscle power training and detraining on physical function in community-dwelling prefrail older adults: a randomized controlled trial. *BMC Geriatr.* 2012;12(1):68.
 13. Cadore EL, Casas-Herrero A, Zambom-Ferraresi F, Idoate F, Millor N, Gómez M, et al. Multicomponent exercises including muscle power training enhance muscle mass, power output, and functional outcomes in institutionalized frail nonagenarians. *Age.* 2014;36(2):773–85.
 14. Glasgow RE, Lichtenstein E, Marcus AC. Why don't we see more translation of health promotion research to practice? Rethinking the efficacy-to-effectiveness transition. *Am J Public Health.* 2003;93(8):1261–7.
 15. Peters DH, Adam T, Alonge O, Agyepong IA, Tran N. Implementation research: what it is and how to do it. *BMJ.* 2013;347:f6753.
 16. Tan QLL, Chye LMY, Ng DHM, Chong MS, Ng TP, Wee SL. Feasibility of a community-based functional power training program for older adults. *Clin Interv Aging.* 2018;13:309–16.
 17. Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, et al. Frailty in older adults: evidence for a phenotype. *J Gerontol A Biol Sci Med Sci.* 2001;56(3):M146-M57.
 18. Chen LK, Liu LK, Woo J, Assantachai P, Auyeung TW, Bahyah KS, et al. Sarcopenia in Asia: consensus report of the Asian Working Group for Sarcopenia. *J Am Med Dir Assoc.* 2014;15(2):95–101.
 19. Empower Ageing Limited. Frailty solutions [Internet]. Singapore: Empower Ageing Limited [updated 2020 June 29; cited 2020 June 29]. Available from: <http://www.empower.org.sg/frailty-solutions>.
 20. HPBsg. You Can Get Moving - Step by Step Demonstration Video (English version) [video file]. 2017 Mar 26 [cited 2020 June 26]. Available from: <https://www.youtube.com/watch?v=fLLHEtRbJ8M>.
 21. Rantanen T, Guralnik JM, Foley D, Masaki K, Leveille S, Curb JD, et al. Midlife hand grip strength as a predictor of old age disability. *J Am Med Assoc.* 1999;281(6):558–60.
 22. Guralnik JM, Ferrucci L, Simonsick EM, Salive ME, Wallace RB. Lower-extremity function in persons over the age of 70 years as a predictor of subsequent disability. *N Engl J Med.* 1995;332(9):556–62.
 23. Shumway-Cook A, Brauer S, Woollacott M. Predicting the probability for falls in community-dwelling older adults using the Timed Up & Go Test. *Phys Ther.* 2000;80(9):896–903.
 24. Mijnders DM, Meijers JM, Halfens RJ, ter Borg S, Luiking YC, Verlaan S, et al. Validity and reliability of tools to measure muscle mass, strength, and physical performance in community-dwelling older people: a systematic review. *J Am Med Dir Assoc.* 2013;14(3):170–8.
 25. Guralnik JM, Simonsick EM, Ferrucci L, Glynn RJ, Berkman LF, Blazer DG, et al. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. *J Gerontol.* 1994;49(2):M85–94.
 26. Ware JE Jr, Kosinski M, Keller SD. A 12-Item Short-Form Health Survey: construction of scales and preliminary tests of reliability and validity. *Med Care.* 1996;220–33.

27. Stel VS, Smit JH, Pluijm SM, Visser M, Deeg DJ, Lips P. Comparison of the LASA Physical Activity Questionnaire with a 7-day diary and pedometer. *J Clin Epidemiol.* 2004;57(3):252–8.
28. Folstein MF, Folstein SE, McHugh PR. “Mini-mental state”: a practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res.* 1975;12(3):189–98.
29. Glasgow RE, Vogt TM, Boles SM. Evaluating the public health impact of health promotion interventions: the RE-AIM framework. *Am J Public Health.* 1999;89(9):1322–7.
30. Moher D, Schulz KF, Altman DG, Group C. The CONSORT statement: revised recommendations for improving the quality of reports of parallel-group randomised trials. *Lancet.* 2001;357(9263):1191–4.
31. Hopkins W, Marshall S, Batterham A, Hanin J. Progressive statistics for studies in sports medicine and exercise science. *Med Sci Sports Exerc.* 2009;41(1):3–12.
32. Cadore EL, Izquierdo M. Muscle power training: a hallmark for muscle function retaining in frail clinical setting. *J Am Med Dir Assoc.* 2018;19(3):190–2.
33. Tarazona-Santabalbina FJ, Gómez-Cabrera MC, Pérez-Ros P, Martínez-Arnau FM, Cabo H, Tsaparas K, et al. A multicomponent exercise intervention that reverses frailty and improves cognition, emotion, and social networking in the community-dwelling frail elderly: a randomized clinical trial. *J Am Med Dir Assoc.* 2016;17(5):426–33.
34. Giné-Garriga M, Guerra M, Pagès E, Manini TM, Jiménez R, Unnithan VB. The effect of functional circuit training on physical frailty in frail older adults: a randomized controlled trial. *J Aging Phys Activ.* 2010;18(4):401–24.
35. Perera S, Mody SH, Woodman RC, Studenski SA. Meaningful change and responsiveness in common physical performance measures in older adults. *J Am Geriatr Soc.* 2006;54(5):743–9.
36. Bean JF, Kiely DK, LaRose S, O'Neill E, Goldstein R, Frontera WR. Increased velocity exercise specific to task training versus the National Institute on Aging's strength training program: changes in limb power and mobility. *J Gerontol A Biol Sci Med Sci.* 2009;64(9):983–91.
37. Steib S, Schoene D, Pfeifer K. Dose-response relationship of resistance training in older adults: a meta-analysis. *Med Sci Sports Exerc.* 2010;42(5):902–14.
38. Cadore EL, Rodríguez-Mañas L, Sinclair A, Izquierdo M. Effects of different exercise interventions on risk of falls, gait ability, and balance in physically frail older adults: a systematic review. *Rejuvenation Res.* 2013;16(2):105–14.
39. Manini T, Marko M, VanArnam T, Cook S, Fernhall B, Burke J, et al. Efficacy of resistance and task-specific exercise in older adults who modify tasks of everyday life. *J Gerontol A Biol Sci Med Sci.* 2007;62(6):616–23.
40. GYM Challenge. Power Up Monday! (GYM Transformation Online) [video file]. 2020 May 25 [cited 2020 June 26]. Available from: https://www.facebook.com/watch/live/?v=856617714818160&ref=watch_permalink.

Tables

Table 1

12-Week functional power training intervention program

Components	Wk 1-Wk 2	Wk 3-Wk 4	Wk 5-Wk 6	Wk 7-Wk 8	Wk 9-Wk 10	Wk 11-Wk 12
Lower-body power	<ul style="list-style-type: none"> · Sit to stand · Standing knee ups · Standing calf raises 	<ul style="list-style-type: none"> · Sit to stand* · Hip extension · Standing toe up · Seated heel drag* 	<ul style="list-style-type: none"> · Squats · Hip extension* · Calf raises with toe ups 	<ul style="list-style-type: none"> · Sit to stand* · Standing knee ups* · Hip abduction · Seated heel drag* · Knee flexion and hip extension* 	<ul style="list-style-type: none"> · Sit to stand plus swap seats* · Seated knee extension* · Calf raises with toe ups 	<ul style="list-style-type: none"> · Squats plus press · Hip extension* · Standing knee ups*
Upper-body power	<ul style="list-style-type: none"> · Bicep curl* 	<ul style="list-style-type: none"> · Chest press* 	<ul style="list-style-type: none"> · Seated low row 	<ul style="list-style-type: none"> · Chest press* · Shoulder press* 	<ul style="list-style-type: none"> · Bicep curl* 	<ul style="list-style-type: none"> · Standing row · Shoulder press*
Balance and mobility	<ul style="list-style-type: none"> · Tandem balance · Clock tapping · Side reach · Zigzag walk 	<ul style="list-style-type: none"> · Side-to-side plus reach · Marching with side step · Tandem walk 	<ul style="list-style-type: none"> · Clock tapping · Mini lunges · Speed walk · Side step · Tandem walk 	<ul style="list-style-type: none"> · Speed plus zigzag walk relay 	<ul style="list-style-type: none"> · Quick feet · Mini lunges 	<ul style="list-style-type: none"> · Quick feet · Speed walk · Crossing creek · Farmer's walk

* Exercise performed with resistance bands

Table 2

Baseline characteristics of participants in both CG and IG.

	Control Group (<i>n</i> = 30)	Intervention Group (<i>n</i> = 27)	<i>p</i>
Age (years)	71.53 ± 7.99	72.07 ± 8.14	0.802
Gender, female	28 (93.3%)	25 (92.6%)	1.000
BMI (kg/m ²)	23.45 ± 3.59	25.30 ± 5.44	0.141
WC (cm)	83.68 ± 11.00	86.41 ± 11.62	0.369
MMSE	26.30 ± 3.22	25.48 ± 2.87	0.315
EE (kcal/week)	3448.80 ± 2613.28	3835.37 ± 2410.26	0.564
Smoking history	1 (3.3%)	0 (0.0%)	1.000
CVD	0 (0.0 %)	2 (7.4%)	0.426
Hypertension	21 (70.0%)	17 (63.0%)	0.778
High Cholesterol	18 (60.0%)	15 (55.6%)	0.944
Osteoporosis	7 (23.3%)	4 (14.8%)	0.633
Osteopenia	4 (13.3%)	2 (7.4%)	0.768
Stroke	0 (0.0%)	2 (7.4%)	0.426
Diabetes	8 (26.7%)	7 (25.9%)	1.000
Arthritis	15 (50.0%)	10 (37.0%)	0.473

Data presented in n (%) or mean ± SD.

BMI, body mass index; WC, waist circumference; MMSE, mini-mental state examination; EE, energy expenditure; CVD, cardiovascular disease.

Table 3

Outcome measures at baseline and 3-month follow-up across CG and IG.

	Control Group			Intervention Group			Group-time interaction <i>p</i> -value
	Baseline (<i>n</i> = 30)	3-month (<i>n</i> = 27)	<i>p</i> -value	Baseline (<i>n</i> = 27)	3-month (<i>n</i> = 23)	<i>p</i> -value	
Frailty status	1.33 ± 0.55	1.07 ± 0.73	0.035*	1.30 ± 0.54	0.96 ± 0.77	0.011*	0.644
HGS (kg)	17.40 ± 3.95	18.64 ± 4.81	0.020*	18.10 ± 3.65	18.70 ± 4.52	0.146	0.584
KES (kg)	16.66 ± 5.89	16.56 ± 4.22	0.919	15.87 ± 5.83	17.00 ± 4.82	0.220	0.332
TUG (s)	9.22 ± 3.27	9.50 ± 4.13	0.712	8.92 ± 2.49	8.32 ± 2.27	0.080	0.124
SPPB (pt)	10.90 ± 1.65	10.81 ± 2.00	0.933	10.85 ± 1.46	11.52 ± 0.73	0.010*	0.047*
Balance (pt)	3.73 ± 0.58	3.59 ± 0.80	0.162	3.67 ± 0.68	3.74 ± 0.54	0.632	0.193
Gait Speed (pt)	3.73 ± 0.58	3.70 ± 0.67	0.938	3.78 ± 0.58	3.91 ± 0.29	0.379	0.485
Chair Stand (pt)	3.43 ± 1.04	3.44 ± 1.09	0.632	3.41 ± 0.69	3.87 ± 0.34	0.002*	0.048*

Data presented in mean ± SD.

HGS, handgrip strength; KES, knee extensor strength; TUG, timed up and go; SPPB, short physical performance battery. * *p* < 0.05.

Table 4

Responses on intervention participant experience (n = 23).

Questionnaire Items	Score
The exercise program was well structured, organized, and easy to follow.	4.35 ± 0.49
The exercise program was fun, enjoyable and engaging.	4.57 ± 0.59
The exercise program was relevant to my daily activities.	4.13 ± 0.92
The exercise program helped to improve my social interaction with other participants.	4.04 ± 0.82
After the exercise program, I feel more energetic and happy.	4.35 ± 0.65
After the exercise program, I feel stronger and confident with daily activities.	4.30 ± 0.56
I feel that I have benefited from the exercise program.	4.52 ± 0.51
I will recommend this exercise program to others.	4.48 ± 0.51
I will participate in such exercise program in the future.	4.52 ± 0.51

Data presented in mean ± SD.

Figures

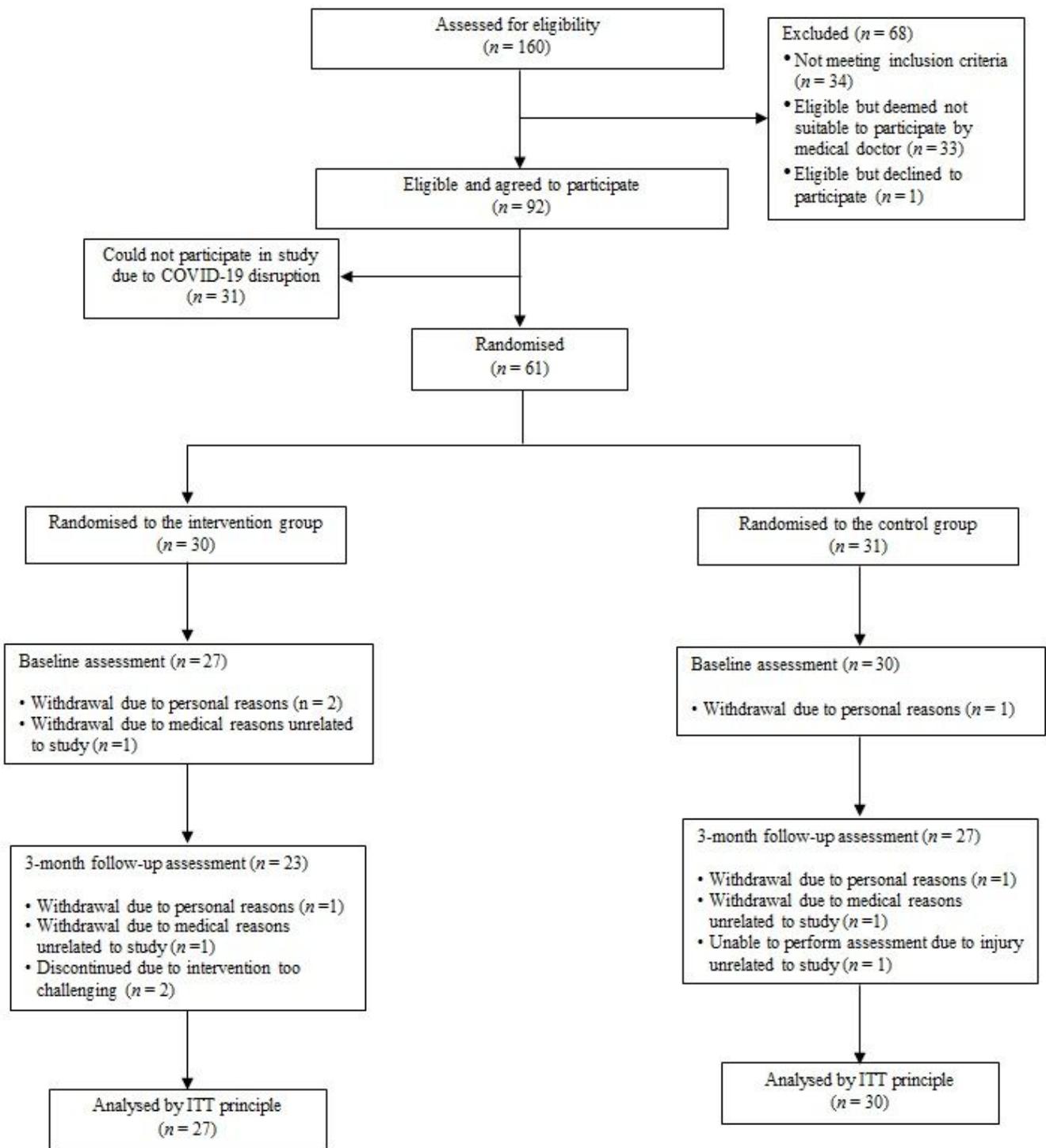


Figure 1

Study flow diagram. Legend: ITT, intention-to-treat

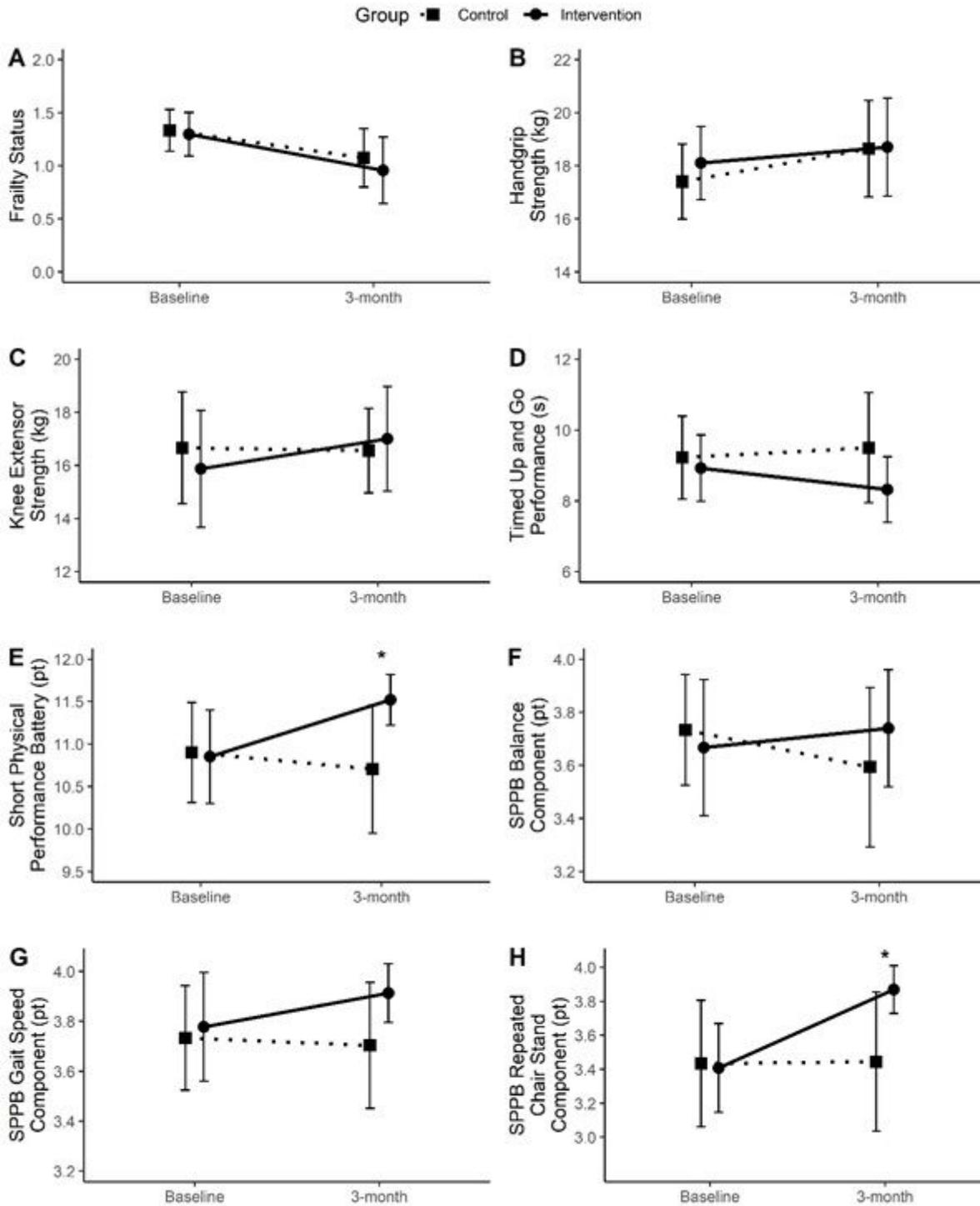


Figure 2

Outcome measures at baseline and 3-month follow-up across groups. Legend: A: Frailty status; B: Handgrip strength; C: Knee extensor strength; D: Timed up and go performance; E: Short physical performance battery; F: SPPB balance component; G: SPPB gait speed component; H: SPPB repeated chair stand component. * Significant group-time interaction ($p < 0.05$). Data presented in mean \pm 95CI.

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