

Mind-body training – a single-arm feasibility study of community-delivered Baduanjin training for frail older adults

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Abstract

Background Frailty is a common geriatric syndrome, characterized by reduced physiologic reserve and increased vulnerability to stressors, due to cumulative decline in multiple physiological systems. Our study examined the feasibility and effects of a community-delivered BDJ training program among prefrail/frail community-dwelling older people in preparation for a randomised control implementation study.

Methods Our study was a single arm feasibility study in community setting. Eleven participants (aged 77 ± 6 years; 2 frail, 9 prefrail at baseline) completed the program. Sixteen week group BDJ training co-designed and implemented by community-based providers in Singapore. Recruitment, attendance and adverse events were recorded throughout the training. A participants' survey was also administered after the training program. Effects of the intervention on physical and functional outcomes (hand grip strength, knee extension strength, Time Up and Go (TUG), Physiological Profile Assessment (PPA), 30-second Sit-to-Stand test, 6-meter fast gait speed test), frailty outcomes (frailty score and status), and other outcomes (Maastricht Questionnaire (MQ), Fall Efficacy Scale (FES), Montreal Cognitive Assessment (MoCA), Geriatric Depression Scale (GDS), and EQ-5D-5L) were examined before and after the program.

Results Of 31 older adults screened to be frail, 15 met inclusion criteria and 3 refused participation resulting in 12 older adults enrolled in the program. One participant was hospitalized (unrelated to BDJ training) and the other 11 completed the program with average overall attendance of 89%. Most (89%) of the 44 training sessions had attendance $> 80\%$. The program received positive feedback with no training-related adverse events. Participants either reversed ($n = 2$) or maintained ($n = 9$) their frailty statuses. There were significant within-group post-training improvements in hand grip strength ($p = 0.013$), knee extension strength ($p = 0.048$), TUG ($p = 0.018$), MQ ($p = 0.001$), FES ($p = 0.022$), MoCA ($p = 0.014$), GDS ($p = 0.028$), EQ-5D-5L index score ($p = 0.029$). The reduction of frailty score and PPA fall risk score showed moderate-to-large effect size.

Conclusions Community-delivered BDJ training program was safe and feasible for prefrail/frail older adults with the potential to improve physical and cognitive function, reduce fall risk, improve psychological well-being, and reverse frailty status.

Background

Frailty is a common geriatric syndrome, characterized by reduced physiologic reserve and increased vulnerability to stressors, due to cumulative decline in multiple physiological systems (1). The prevalence of frailty among community-dwelling older people has been reported to be between 4.0–59.1% (2). A quarter to a half of people older than 85 years has been estimated to be frail (3). Recently, frailty has been recognized as a public health priority because of its high prevalence and predictive capacity for functional disability, hospitalization, institutionalization and death (4, 5). The frailty process is a transitional, with dynamic progression from robust, to prefrail, and to frail, which can improve or worsen

over time (3, 6, 7). This highlights the importance of frailty identification, prevention, reduction and management.

Different interventions to reduce frailty have been studied (8–10). Recent reviews highlighted the importance of physical exercise in reducing frailty and improving function in prefrail/frail older adults (11, 12). Economic study also demonstrated that physical exercise is cost-effective in preventing the progression of frailty and disability in older adults living in the community (13). However, compared with the general older population, prefrail/frail older adults have relatively lower tolerance to intense physical exercise and are usually more sedentary than non-frail counterparts (low physical activity being a defining feature of frailty) in the same age group. It is therefore important to consider the acceptability, tolerability and safety in recommending physical training program for prefrail/frail older adults to participate and enjoy in the community where they lived.

Baduanjin (BDJ), also known as Eight-Section Brocades, is one common form of “mind-body” Qigong. It involves eight simple movements with combinations of postures, meditation, slow relaxing movements, and breathing exercise in a harmonious manner which enhances respiratory function, improves holistic health and achieves the integration of mind and body (14). Compared with relatively more complex and lengthy exercise forms such as Tai Chi, BDJ is less physically and cognitively demanding; and is easy to learn and practice with few limitations (15). Thus, it may be suitable for older adults and those who are frail. Systematic reviews (16, 17) have indicated that BDJ is popular and confers health benefits including physical fitness (18–20), mental health (21, 22) and quality of life (23–25) in different populations. However, to our knowledge, there is yet any study of BDJ training in prefrail/frail older adults.

There are many factors to consider in translating the result of a successful clinical trial into real life settings (26). As such, there is merit in implementing an intervention in a community setting where it is most applicable. Furthermore, considering the vulnerabilities of the target population of frail older adults, there is a need for a feasibility study to first understand the safety, acceptance and adherence of the intervention to be delivered in a community setting. The primary aim of this single arm study was to determine the safety, acceptability of and adherence to community-delivered BDJ program among pre-frail and frail older adults. We also aimed to estimate the effect sizes of the potential functional outcomes in order to inform sample size estimation of a randomised controlled study in the same community-dwelling population.

Methods

Setting and participants

This feasibility study was designed as a single arm pre–post comparison. In partnership with a provider of senior community services (day care and community clinic), the study was implemented at a community center, where the provider is based at the Whampoa housing estate in Singapore. A small

convenience sample of older adults was recruited by the provider amongst the visitors of the community center, daycare center, and community clinic at the same locale.

The inclusion criteria were: 1) pre-frail (score 1–2) or frail (scored 3–5) according to FRAIL scale screening questionnaire (27); 2) older adults aged 55 years and above ; 3) able to ambulate without personal assistance and has no other physical limitations which limited participation; 4) able to understand basic instructions; and 5) generally sedentary lifestyle according to Physical Activity Scale for the Elderly (PASE) questionnaire (28) (self-reported participating in sitting activities at least 5 days per week with more than 4 hours per day on average).

Exclusion criteria were as follows :1) participating in any other exercise program or interventional studies; 2) severe audio-visual impairment diagnosed by physicians; 3) diagnosed with cognitive impairment and/or history of neurological disorder; 4) unable to participate for the full duration of the study; 5) diagnosed with postural hypotension.

BDJ training program

The program was designed by the local Qigong association. The entire set of BDJ exercise comprises eight sections (Fig. 1). Participants underwent a group-based 16-week supervised BDJ training program with a total of 44 training sessions. Each session lasted 90 minutes including warming up, BDJ exercise, and cool down. During the first four weeks, participants practiced each section of BDJ twice a week with the training intensity gradually increased to familiarize with the training. During the following 12-week period, participants practiced the whole set of BDJ exercise for 90 minutes three times a week. Two professional Qigong trainers from the local Qigong association conducted the training in both English and Chinese as appropriate.

All participants cleared pre-exercise medical examination before recruitment into the study. Simple screening was performed by study coordinator before each training session. Participant with either one of the following did not participate for that training session: blood oxygen levels below 95% saturation; high resting heart rate (29); abnormal resting blood pressure (30); giddiness; or any form of discomfort. During training, each participant had a chair with armrests behind them so anyone who felt unstable can sit down. Two community volunteers assisted to ensure the seniors' safety during exercise.

Measurements

Program Feasibility

To assess the feasibility of the training program, we recorded the attendance at each training session, attrition rate, and adverse events throughout the training program. A survey was also administered to the participants after the training program. The survey utilized a four-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = agree, and 4 = strongly agree) and comprised nine questions on program acceptance, adherence satisfaction, engagement, and willingness for continued participation. Any adverse event during the program duration was recorded.

Other training outcomes

To explore the potential effects of BDJ, we assessed a range of exploratory outcomes during the week before (pre) and the week after (post) the 16-week training program. All outcome measures were administered by assessors who were blinded to the study design and not involved in BDJ instruction and demonstration.

Physical and functional outcomes

Physical and functional outcomes included knee extension strength, hand grip strength, 6-meter fast gait speed test, Time Up and Go test (TUG), Physiological Profile Assessment (PPA), and 30-second Sit-to-Stand (30 s STS) test.

To assess muscle strength, knee extension strength and hand grip strength were measured using a spring gauge and hand-grip dynamometer respectively for the dominate leg or hand. Two trials were administered for knee extension strength, hand grip strength, and 6-meter fast gait speed test and the mean values used for analyses.

TUG, a test of basic functional mobility for frail elderly persons, required participants to stand up from a chair, walk a distance of 3 m at a comfortable pace, turn, walk back, and sit down (31). The test was performed twice, with the shorter time of two trials used for analysis.

PPA, which includes five measures of physiological functioning (postural sway, knee extension strength, reaction time, lower limb proprioception and visual contrast sensitivity), was used as a systematic approach to explore the underlying causes of balance changes (32). The five components were weighted to compute a composite PPA fall risk score, where higher composite scores indicate higher risks of falling.

For the 30 s STS, the number of successful stands within 30 seconds were recorded. The performance of 30 s STS has been suggested to be determined by balance, muscle strength, lower extremity endurance, as well as mobility (33).

Frailty outcomes

Frailty score of the participants was assessed using the Cardiovascular Health Study Frailty Phenotype (CHS Fried criteria).(1) The five criteria were: 1) shrinking (defined as unintentional weight loss > 4.5 kg and/or BMI of < 18.5 kg/m² in the last 6 months by self-report); 2) weakness, assessed by knee extension strength of the dominant leg according to cut off points stratified by gender and BMI (Asian classification) ((a) in men: underweight: <9.5 kg, normal weight: <12.3 kg, overweight: <14.7 kg, obese: <15.0 kg; (b) in women: underweight: <9.3 kg, normal weight: <10.0 kg, overweight: <10.0 kg, obese: <10.0 kg). 3) slowness, established according to a cutoff point of < 0.8 m/s by 6-meter fast gait speed test; 4) exhaustion was measured with the 3 questions on vitality domain in the Medical Outcomes Study 12-Item Short-Form Health Survey (34) "Did you feel worn out?" "Did you feel tired?" "Did you have a lot

of energy?” with total summed scores ranging from 3 to 15, and a score of less than 10 was used to denote exhaustion; and 5) physical inactivity, measured by Longitudinal Aging Study Amsterdam Physical Activity Questionnaire (35). One-point was assigned for the presence of each component, and based on the individual’s total score, participants were categorized as frail (3–5 points), pre-frail (1–2 points), and robust (0 point). Reduction in frailty during the study was defined as a transition to a lower frailty category from baseline to post-training program.

Other outcomes

We also measured participants’ vital exhaustion using Maastricht Questionnaire (MQ) (36), and fear of falling using Fall Efficacy Scale (FES) (37). Other outcomes also included Montreal Cognitive Assessment (MoCA) (38) for cognitive function; EQ-5D-5L (39) index score for the health-related quality of life; and the 16-item short form Geriatric Depression Scale (GDS) (40) to assess depression status.

Sample size and statistical analyses

A relatively small sample ($n = 20$) of participants was selected to investigate the feasibility of BDJ intervention. A power calculation was not used, as there were no references for this specific population. Hence, our results would provide the required information to perform power calculations for future studies.

Descriptive statistics of demographic information and outcome measurements were presented as mean and Standard Deviation (SD) for continuous variables, and frequencies and percentages for categorical variables. One-sided paired t-tests were used to compare pre-post outcome measurements. Results from the outcome measurements were summarized and effect size of each test was calculated using Cohen’s d . Results of the post intervention interview was reported as the percentage of responses for each question. All analyses were conducted using Stata 14.0 (StataCorp LP, College Station, TX) with $p = 0.05$ as the level of statistical significance.

Results

Characteristics of the Participants

During the 3-month screening and recruitment in the community, 31 prefrail/frail older adults were identified using FRAIL scale. Of those, 16 older adults not meeting inclusion criteria were excluded and another three declined to participate. In the end, twelve participants aged between 65 to 84 years old (mean = 77.1, SD = 5.9) were enrolled at baseline. Among them, eleven participants completed the 16-week program and one dropped out due to hospitalization unrelated to training program. The participants were all Chinese and had an average of 2.75 chronic illnesses - hypertension (91.7%), diabetes (50%), hyperlipidemia (41.7%), arthritis (33.3%), and heart disease (25%) were the top five comorbidities. 50% of the participants used walking aids. According to CHS Fried criteria, 10 participants were prefrail, and two were frail at baseline. (Table 1)

Table 1
Baseline characteristics of study participants (n = 12)

Demographics	Mean (SD) or frequency (%)
Age	77.1 (5.9) ^a
Gender	
<i>Female</i>	9 (75%) ^b
<i>Male</i>	3 (25%)
Race/Ethnicity	
<i>Chinese</i>	12 (100%)
Education	
<i>No formal education</i>	3 (25%)
<i>Primary school</i>	2 (16.7%)
<i>Secondary school</i>	7 (58.3%)
Living status	
<i>With family</i>	11 (91.7%)
<i>Alone</i>	1 (8.3%)
Marital status	
<i>Married</i>	11 (91.7%)
<i>Single</i>	1 (8.3%)
Smoking status	
<i>Non-smoker</i>	11 (91.7%)
<i>Ex-smoker</i>	1 (8.3%)
Alcohol intake	
<i>Non-alcohol</i>	11 (91.7%)
<i>Regular</i>	1 (8.3%)
Falls in past 6 month	4 (33.3%)
Frailty Status (Fried criteria)	
<i>Prefrail</i>	10 (83.3%)

Demographics	Mean (SD) or frequency (%)
<i>Frail</i>	2 (16.7%)
BMI	26 (3.7)
Comorbidities	2.8 (2)
<i>Hypertension</i>	11 (91.7%)
<i>Diabetes</i>	6 (50%)
<i>Hyperlipidaemia</i>	5 (41.7%)
<i>Arthritis</i>	4 (33.3%)
<i>Heart disease</i>	3 (25%)
Mobility aids	6 (50%)
<i>Independent</i>	6 (50%)
<i>Canes</i>	3 (25%)
<i>Mobility walker</i>	1 (8.3%)
<i>Wheelchair</i>	2 (16.7%)
^a Data are presented as mean (standard deviation) for all such values; ^b Data are presented as frequency (%) for all such values. Abbreviations: BMI = body mass index.	

Table 1. **Baseline characteristics of study participants (n = 12)**

Feasibility of BDJ training program

The training program was found to be safe for these frail participants. Over the 16-week BDJ training program, there were no training-related fall, injuries, or serious adverse events. Overall, the group demonstrated good adherence, completing an average of 88.6% attendance for the 44 training sessions. Among the 44 sessions, 23% of the training sessions (n = 10) had full attendance, 66% (n = 29) had an attendance of 80–100%, and only 11% (n = 5) had an attendance of lower than 80%. (Fig. 2)

Nine (83%) participants had an adherence of more than 80% throughout the training program (Fig. 3), among them, two participants achieved 100% program attendance. Of note, the two participants with lower adherence experienced one hospitalization episode each due to issues unrelated to the training.

In addition, participants' experience of the program was uniformly positive. As shown in Fig. 4, participants perceived the program to be engaging, with relevant physical, psychological, and social benefit. They would also recommend the program to others and continue the training after the program.

Only two questions received one “Disagree” response each to the statements: “I will recommend this BDJ program to others” and “I will participate in such BDJ program in the future”, while all the rest indicated of “Agree” or “Strongly agree”.

Potential effects of BDJ training program

All the 11 participants who completed the post assessments were analyzed as complete cases. Statistically significant improvements in physical outcomes were recorded in TUG ($p = 0.018$), hand grip strength ($p = 0.013$), and knee extension strength (0.048) with moderate-to-large effect size. A moderate effect size difference was shown in the reduction of PPA fall risk and frailty scores. Among the five components of PPA, significant improvement was only shown in knee extension strength while other components were unchanged. We did not identify any change in the 6-meter fast gait and 30 s STS tests (all $p > 0.10$). (Table 2)

Table 2
Results of explorative outcomes (n = 11)

Outcomes	Baseline (mean ± SD)	Post training (mean ± SD)	Mean of difference (Post vs baseline)			Paired t-test p-value	Cohen's d effect size	Participants achieved improvement n (%)
			Mean ± SD	95% CI	%			
Time Up and Go (s)	16.1 ± 5.2	13.8 ± 4.4	-2.3 ± 2.9	[-4.4, -0.2]	14.3%	0.018	-0.47	7 (64%)
Grip strength (kg)	16.8 ± 5.5	18.4 ± 5.8	1.6 ± 2.0	[0.2, 2.9]	9.5%	0.013	0.28	8 (73%)
Knee extension strength (kg)	14.5 ± 4.1	17.5 ± 4.3	2.9 ± 5.3	[-0.6, 6.5]	20.2%	0.048	0.69	6 (55%)
PPA composite fall risk score	2.2 ± 1.4	1.5 ± 0.9	-0.7 ± 1.4	[-1.6, 0.3]	30.5%	0.070	-0.59	6 (55%)
6-meter fast gait speed (s)	1.2 ± 0.4	1.2 ± 0.4	0.0 ± 0.2	[-0.2, 0.1]	1.0%	0.377	-0.06	3 (27%)
30-second Sit-to-Stand test	12.3 ± 3.0	11.5 ± 3.7	-0.7 ± 2.6	[-2.5, 1.0]	5.9%	0.185	-0.22	5 (45%)
Frailty Score (Fried criteria)	1.5 ± 0.8	1.2 ± 0.4	-0.4 ± 0.7	[-0.8, 0.1]	24.0%	0.052	-0.56	3 (27%)
Fall Efficacy Scale	28.8 ± 9.4	23.3 ± 6.2	-5.4 ± 7.9	[-10.8, -0.2]	18.8%	0.022	-0.68	7 (64%)
MQ score	15.0 ± 8.1	8.6 ± 5.6	-6.6 ± 5.1	[-9.8, -2.9]	44.2%	0.001	-0.91	10 (91%)
MoCA	22.5 ± 4.1	24.3 ± 4.8	1.8 ± 2.4	[0.2, 3.4]	8.1%	0.014	0.41	9 (82%)
GDS score	3.7 ± 3.5	2.2 ± 1.6	-1.6 ± 2.4	[-3.1, 0.1]	41.5%	0.028	-0.57	8 (73%)
EQ-5D-5L Index score	0.7 ± 0.3	0.9 ± 0.2	0.2 ± 0.3	[0.0, 0.3]	21.9%	0.029	0.66	5 (45%)
Abbreviations: CI = confidence interval; GDS = Geriatric Depression Scale; MoCA = Montreal Cognitive Assessment; MQ = Maastricht vital exhaustion score; PPA = Physiological Profile Assessment; SD = standard deviation.								

By the end of the training program, 3 participants recorded reduced frailty scores with a within-person change of 24%. Both the frail participants (n = 2) reversed to prefrail status. (Table 2)

There was a strong trend towards improvement in subjective and cognitive outcomes. Among the 11 participants, MQ scores improved in 10 (91%), MoCA in 9 (82%), GDS in 8(73%), and FES in 7 (64%), respectively with a within-person change ranging from 8.1%-44.2%. (Table 2) Four participants who were categorized as depressive using GDS at baseline reverted to normal.

Discussion

With a rapidly aging population around the world, frailty has become a major public health concern for both the older adults and society (41). As such, there is a need to provide evidence-based interventions targeting prefrail/frail older adults for community translation. The results of our feasibility study suggest that the 16-week community-delivered BDJ training program is safe has very good acceptance and adherence in the selected group and potentially effective in improving health, function and psychological outcomes among prefrail/frail older adults.

Program safety is vital for health promotion in the vulnerable population of frail older people. Our study intervention assessed BDJ exercise safety with close monitoring on health indicators such as blood pressure and blood oxygen levels before and after each training session. With no training-related adverse events, the current BDJ training program is safe for prefrail/frail older adults.

Program adherence is a significant challenge for exercise interventions in frail persons (42). Poor program adherence leads to sub-optimal intervention dosage and health benefits. Prefrail/frail older adults with physical and/or cognitive function deficit may have greater difficulties adhering to exercise training. Feasibility of this community delivered BDJ program is supported by the high average adherence rate of 88.6%, as well as result from participants' survey. It was noted that those participants even performed BDJ at home during the 16-week intervention as well as spontaneously continued with program in the community after the completion of the study.

A systematic review showed the older people's adherence to exercise programs was associated with the program characteristics and personal factors (43). It was also suggested that the simple and slow movement nature of BDJ made it a suitable option for older adults (44). The eight simple movements may enhance the older adults' confidence in performing the exercise and compliance to training. Cultural identity and self-efficacy are important personal factors for adherence. Some older Chinese adults maybe keen to participate BDJ due to favourable perceptions on Chinese Traditional Medicine (TCM). Moreover, to motivate participants' participation, the Qigong trainers employed strategies to enhance the program experience - instructing the BDJ exercise in a fun way and nominating peer models in the class, which may have promoted self-efficacy, and greater enjoyment of the program participation. Our community partner also provided snacks and drinks after each session, which encouraged social interactions that further promoted participation, as supported by the program adherence and participant survey results. This underlines the importance of community partnership and other implementation factors in community program translation (45).

Falls have significant impacts on older adults including loss of mobility and confidence to maintain daily activities, leading to frequent hospitalizations and greater need for social care (46, 47). Muscle strength and balance are two essential components of physical fitness which provide information about the older adults' capacities to reduce fall risk. Furthermore, reduced strength and balance also restrict their performance of activities of daily living, especially among the prefrail/frail. Our results suggest that BDJ training may confer benefits to muscle strength and balance, with potential to reduce fall risk.

First of all, we have observed better hand grip strength ($p = 0.013$) after the 16-week BDJ training, which is consistent with other previous studies conducted among college students (20, 48, 49) as well as healthy sedentary older adults (23, 50). This allows us to add our results on hand grip strength to fill in the existing gap of knowledge among the prefrail/frail population. This potential improvement in hand grip strength may be attributed to the elements of dynamic tension particularly in the execution of exercise G, which involves thrusting of the fists. (Fig. 1)

Secondly, we also observed better lower limb strength following BDJ training, with a large effect size for knee extension strength (Cohen's $d = 0.69$, $p = 0.048$). Only one previous study by Bao et.al in 2019 had examined the effect of BDJ on lower limb strength but showed no improvements (51). This potential difference may be due to the different styles of BDJ intervention - Bao's study utilized the modified seated BDJ, whereas ours was the traditional standing BDJ, which involved the low horse stance to train the leg musculature. BDJ's elements of dynamic tension in the quadriceps are apparent in the execution of low horse exercise stances in B, E and G. (Fig. 1: B, E, G) Dynamic tension is a strength training method that pits muscle against muscle via isometric contraction.

Furthermore, a number of studies have shown that BDJ consistently improved the balance of older adults (19, 50, 52, 53). Consistent with the literature, our study found that BDJ led to potential decreases in TUG ($p = 0.018$) and FES ($p = 0.022$). The possible mechanisms to explain the improvements in balance include: 1) BDJ may increase flexibility and dynamic mobility by the coordinated motions of the head, trunk, and extremities; 2) BDJ movements are performed slowly with focus placed on being conscious of where their body parts are, which may promote proprioceptive awareness (51); 3) Increased muscle strength may enhance balance function. In our study, according to the results of the individual PPA components, the significant improvement on balance was mostly attributed to lower limb strength, which contributed a medium effect size reduction on the PPA fall risk score. There was no obvious change for other components including edge contrast sensitivity, lower limb proprioception, hand reaction time, and postural sway. However, since our sample size was small, it is difficult to draw a definitive conclusion. Thus, future studies can examine the mechanisms of balance improvement from doing BDJ.

Recent review showed emerging studies have explored the different exercises as interventions for frailty (11). In our study, after 16-week BDJ intervention, frailty scores resulted in a marginal significant reduction of medium effect size ($p = 0.052$, Cohen's $d = -0.59$). Meanwhile, two frail participants at baseline converted to prefrail, suggesting that BDJ could be a potential exercise for frailty reversal. It is worth noting that both of the frail participants were wheelchair users. This may indicate that older adults with

lower functional capacity are more likely to benefit from slow movement exercise such as BDJ. The Asian-Pacific Clinical Practice Guidelines recommended physical activity with a resistance training component as a prescription for frailty management (54). Potential of BDJ training for frailty reduction should be examined in a controlled study.

Apart from its benefits on physical functions, the 16-week BDJ training also seemed to result in better cognitive function (MoCA, $p = 0.014$), psychological well-being (GDS, $p = 0.028$), and quality of life (EQ-5D-5L index score, $p = 0.029$) compared to baseline. These results are consistent with previous studies (23, 25, 55–57), which affirms that BDJ provided a holistic health benefit for older adults. This is in accordance with the TCM theory that BDJ typically involves a mind–body integration to cultivate Qi (vital energy in TCM theory) for maximizing both physical and mental well-being (58). Moreover, our study also used MQ, a validated tool, to explore the effects of Qi. The reduction of MQ score ($p = 0.001$) may indicate the improvement of vital energy after BDJ training. Future studies can employ the use of biochemical energetics to confirm the training effect of BDJ on Qi.

On the other hand, we noticed that our study did not result in any change in 30 s STS and 6-meter fast gait speed test. However, a BDJ randomised control trial (RCT) by Chun et al. (59) resulted in significant improvements on those two outcomes ($p = 0.041$, $p = 0.045$ respectively) in older adults with type 2 diabetes mellitus. Compared to our study, their BDJ intervention frequency was four times a week for 6-months. As 30 s STS and 6-meter fast gait speed test are outcomes associated more with aerobic endurance rather than balance, the inconsistent findings may suggest the improvement in endurance may be achieved with a BDJ intervention of higher frequency and longer duration.

This study is the first to demonstrate that a community based BDJ intervention is safe, feasible, and acceptable among prefrail/frail older persons. The high adherence rate is important for the implementation of such a program in the real-world setting. The strength of the study is the implementation in a “real-world” housing site setting where the participants reside, close partnership with local community providers to engage participation and adherence and using simple equipment such as chairs. To explore the potential effects of BDJ, we assessed a broad range of explorative outcomes including physical and cognitive functions as well as psychological outcomes. As fall risk is an important concern for prefrail/frail seniors, both FES, a subjective assessment, and objective assessments such as TUG and PPA, were conducted to measure the improvements from different perspectives. Furthermore, we explored the Qi component of BDJ exercise using the validated MQ instrument. The results of these explorative outcomes provide information to design a RCT on the effectiveness of BDJ to reduce frailty and improve function. Based on an effect size of 0.7 for within-subject improvement in knee extension strength, with a power of 90% and a 10% drop-out rate, the sample size for a two-arm RCT will be 60 participants.

As a single-arm feasibility study, we could not make any assumptions on the effectiveness of the BDJ training program. The community provider also did not manage to recruit participants of other races than

Chinese (78% of population in Singapore are Chinese). Although not a subject of investigation in this study, it is possible that BDJ is more welcomed by the Chinese than Malay and Indians in Singapore.

The results provide some support to BDJ's potential to be implemented as part of low-cost community health promotion program. As BDJ is an exercise which is easy-to-learn without any restrictions from specialised equipment or spaces, older adults can practise it at home, community activity centres or nursing homes, through both group-based and self-practiced training. Furthermore, BDJ is a traditional Chinese exercise which is popular among Asian Chinese populations. However, to translate the research intervention into a real-world routine community program, efforts from service providers and community partners who have a good intervention fidelity are necessary for a successful implementation. More strategies are needed to maximize the program adherence and achieve the desirable outcomes.

Conclusion

In summary, the study provides early evidence that the 16-week community-delivered BDJ intervention adapted to prefrail/frail older adults is feasible, safe, and acceptable. It may potentially benefit prefrail/frail older adults on physical, cognitive, and psychological health outcomes, and frailty reduction and status reversal. The findings provided information for the design and implementation of a randomized controlled study to investigate the efficacy of BDJ exercise among prefrail/frail older adults.

Abbreviations

BDJ

Baduanjin

BMI

Body Mass Index

CI

Confidence Interval

CHS Fried criteria

Cardiovascular Health Study Frailty Phenotype

FES

Fall Efficacy Scale

GDS

Geriatric Depression Scale

MoCA

Montreal Cognitive Assessment

MQ

Maastricht Questionnaire

PPA

Physiological Profile Assessment

RCT

Randomized Control Trial

SD

Standard Deviation

TCM

Traditional Chinese Medicine

TUG

Time Up and Go

Declarations

Ethics approval and consent to participate

The research protocol was approved by the National Healthcare Group Domain Specific Review Board (Singapore) with reference number DSRB 2018/00590. All recruited subjects provided signed informed consent for this study.

Consent for publication

Both consent form from the BDJ trainers and the participants are all available.

Availability of data and materials

The data are deidentified participant data, which are available on request from the corresponding author Shiou Liang Wee (email: weeshiouliang@gmail.com), upon reasonable request. The data availability must also meet the ethical restrictions. No other additional information is available.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

LX participated in the design of the study, contributed to recruitment, data collection, data entry, and data analysis, and initial manuscript writing. JWTS contributed to recruitment, data collection and data entry. BWJP contributed to data collection and data entry. MAT, FG, WCN contributed to the design of the study. JYRT coordinated the recruitment and training program. TPN and SLW conceptualized and designed the

study and advised on the results interpretation. All authors contributed to the manuscript writing. All authors have read and approved the final version of the manuscript and agree with the order of presentation of the authors.

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Key Messages Regarding Feasibility

1) What uncertainties existed regarding the feasibility?

There is no information on the safety, acceptability, and adherence of community-delivered BDJ training among prefrail/frail older adults.

2) What are the key feasibility findings?

The BDJ training was safe with very good attendance and acceptance among the prefrail/frail community dwelling older adults.

3) What are the implications of the feasibility findings for the design of the main study?

The results of this feasibility study can inform the design and development of randomised controlled study in terms of protocol feasibility, sample size calculation, and outcomes selection.

Figures



Figure 1

Baduanjin exercise A. Holding the hands high with palms up to regulate the internal organs; B. Posing as an archer shooting both left-and right-handed; C. Holding one arm aloft to regulate the functions of the spleen and stomach; D. Looking backwards to prevent sickness and strain; E. Swinging the head lowering the body to relieve stress; F. Moving the hands down the back and legs and touching the feet to strengthen the kidneys; G. Thrusting the fists and making the eyes glare to enhance strength; H. Raising and lowering the heels to cure diseases Translation from: Chinese Health Qigong Association, 2019. Baduanjin. Retrieved Oct 3, 2019, from <http://www.chqa.org.cn/news.php?cid=25&id=543> Note: Please print in color



Figure 2

Adherence rate for each session of the program Note: Please print in colour

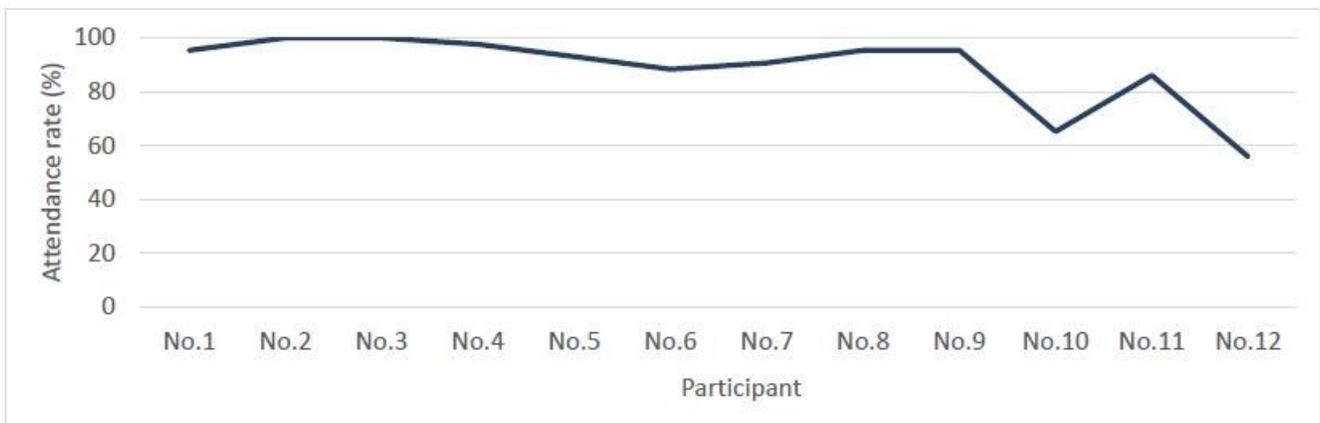


Figure 3

Attendance rate for each participant Note: Please print in colour

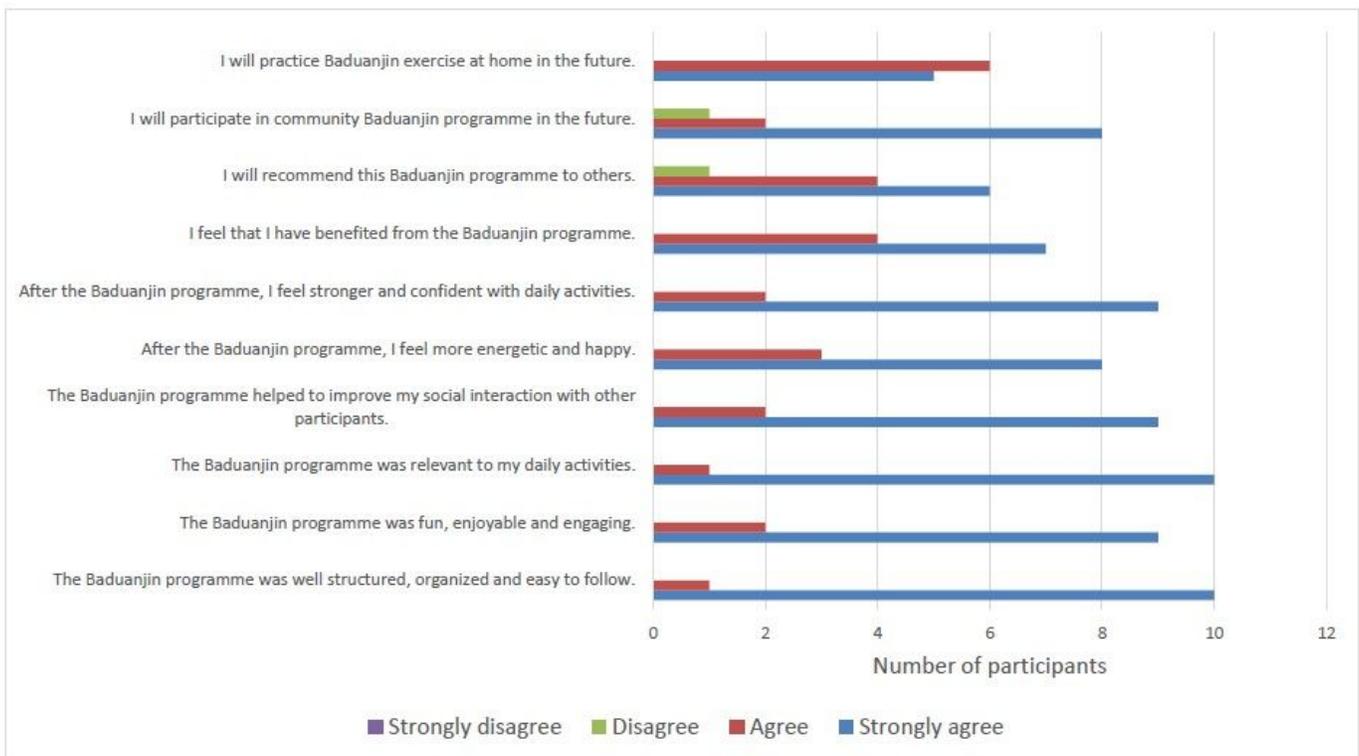


Figure 4

Responses from feedback survey (n=11) Note: Please print in colour

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