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Original Article

The Effects of a Physical Activity Program on Quality of Life and Wellbeing among Community-Dwelling Older People in Taiwan: Empirical Evidence from Taiwan Long-Term Care System 2.0

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SUMMARY

Background: The present study examined the effect of a program to improve physical activity on older people's quality of life and wellbeing.
Methods: Using a quasi-experimental study design and convenience sampling, older people were allocated into an intervention group (receiving physical activity program; n = 75; mean age = 72.41 years; 8 males) or a control group (n = 73; mean age = 71.22 years; 17 males). The intervention group received 24 sessions over an eight-week period, and each session lasted one hour. All participants completed the following outcome measures at baseline and posttest: WHOQOL-AGE to assess quality of life, and Well-Being Scale for Elders to assess wellbeing, as well as muscle strength and balance tests. Independent t-tests, χ^2 tests, analysis of covariance, and multiple linear regression models were used to compare the performance between the two groups.
Results: The intervention group had significantly higher scores or better performance than the control group in quality of life, wellbeing, lower limb strength, and dynamic balance, but not in upper limb strength.
Conclusion: There are multiple benefits for implementing a physical activity program for older people including several aspects of quality of life, wellbeing, lower limb strength, and dynamic balance.

Introduction

The issue of a growing older population is timely and important worldwide.[1-3] Taiwan (where the present study was carried out) also has an aging population: the proportion of older people was 7% in 1993 and doubled to 14% by 2018.[4] Moreover, the growth of older population in Taiwan is not slowing down and it is estimated that Taiwan will become a super-aged society in 2025.[5] Consequently, the Taiwan government needs strategic plans to tackle the issue of aging and reduce the burden and negative consequences caused by an aging population.[6]

One policy that the Taiwan government implemented to tackle the aging issue was to introduce the Long-term Care System version one (LTC 1.0) in 2007.[7] The LTC 1.0 was subsequently reviewed and a new program (i.e., LTC 2.0) was implemented in 2017.[8] Detailed information of the LTC 1.0 and LTC 2.0 services is provided in Supplementary A. Among these

services, the long-term care C-base center (LTC C-base center) is a community center with the focus of letting older people have nearby programs for health maintenance and promotion. LTC C-base center only provides morning activities; therefore, older people attending LTC C-base center live in their home. By using these services, the Taiwan government expects the quality of life and wellbeing of older people to be maintained and improved.

Quality of life (i.e., individuals' overall self-reported health, happiness and comfort across physical, psychological, social, and spiritual dimensions) and wellbeing (i.e., the state of feeling healthy, happy, and prosperous) are important concepts for older people. The importance of quality of life and wellbeing is highly recognized in the health field across different populations,[9,10] including older people.[11] Indeed, quality of life problems are commonplace among older people, especially for those who are frail or have functional problems.[12,13] Therefore, LTC C-base centers are a community resource where healthcare providers can improve older people's functional ability, reduce their frailty problems, and improve quality of life and wellbeing. This is important because quality of life helps healthcare providers understand older people's health condition from a holistic perspective.[14]

Given that LTC C-base centers are community centers for older people, different programs can be implemented in these centers to improve older people's health. One such initiative is the introduction of physical activity programs (i.e., a program specifically designed to improve physical activity) that could be incorporated at the LTC C-base center to help improve older people's quality of life. Prior research has shown that physical activity (i.e., individuals' body movements, especially those that need energy expenditure) is beneficial for older people's physical fitness,[15] activity of daily living,[16] quality of life,[16] and wellbeing.[17,18] Moreover, physical activity program may improve mobility for older adults to engage in various daily activities.[19,20] However, it is unclear if physical activity programs would work in the LTC C-base center because older people in the LTC C-base centers attend the programs voluntarily.

That is, it is unknown if older people would like (or are happy) to engage in a physical activity program in the LTC C-base center.

To provide empirical evidence for the LTC 2.0, the present study evaluated the efficacy of a physical activity program incorporated into community LTC C-base center via a quasi-experimental design. It was hypothesized that older people in the physical activity program (i.e., intervention group) compared with those in a control group (i.e., treatment as usual) would have (i) better quality of life and wellbeing; and (ii) better physical fitness reflected by limb strength and dynamic balance.

Methods

Study design and participants

The present study used a quasi-experimental design with convenience sampling. The participants were allocated into the intervention group or the control group based on their settings (i.e., intervention group participants were in the LTC C-base center [attending morning programs and returning home for living after morning programs]; control group participants were not attending the LTC C-base center). Inclusion criteria for the participants in both groups were being (i) aged 65 years or older and (ii) able to communicate using spoken Mandarin or Taiwanese. The exclusion criteria for both groups were (i) being an inpatient or receiving major surgery in the past year; (ii) having a disease history of cancers, severe neuromuscular diseases and/or respiratory diseases; (iii) self-reporting physical discomfort when engaging in physical activity; and (iv) having mental health issues. The study recruited 150 participants based on the effect size of a recent systematic review and meta-analysis.[21] Detailed information for sample size estimation please refer to Supplementary A. The study was approved by the Institutional Review Board, Human Research Ethics Committee of the Chung Shan Medical University Hospital (IRB: CSMUH No:CS1-21104). All participants provided their written informed

consent prior to the study enrollment.

Sample size estimation

The present study proposed to recruit 150 participants in total with a 1:1 allocation rate between the two groups (i.e., 75 participants in each group). The estimation was based on the following calculation parameters for an independent *t*-test: (i) type I error at 0.05; (ii) power at 0.8; (iii) two-sided test; (iv) effect size at medium level (i.e., Cohen's *d*=0.5); and (v) an attrition rate of 15%. More specifically, the effect size was set at 0.5 because a recent systematic review and meta-analysis on psychological distress improvements showed that exercise improved psychological distress with Cohen's *d* ranging between 0.4 and 0.6.[21]

Program procedure

For the intervention group, an experienced occupational therapist was the group leader who facilitated the participants to engage in the physical activity program (24 sessions during an eight-week period; i.e., three sessions per week). The group size was 10 to 15 people and the exercise time was in the morning. Each session lasted approximately one hour with 10 minutes of warm-up, 40 minutes of main activity, and 10 minutes of cool-down. During the period of main activity, there were two recess periods each lasting 10 minutes long. Apart from the recess periods, the participants could take rest if needed with a research assistant accompanying them. The main activity focused on aerobic training for lower limbs because mobility is important for older people engaging in daily living activities. More specifically, the occupational therapist designed some board games that required the participants to engage in mobility function because the board games offered frequent chances for the participants to walk and move in the treatment space.

For the control group, the participants received usual care provided by a nursing assistant. The nursing assistant accompanied by the participants in the control group with the frequency and duration of the usual care in the control group the same as those of the intervention in the

intervention group. In the usual care, the nursing assistant chatted with the older people and only provided assistance when the older people asked. Most of time, the older people did not ask any assistance from the nursing assistant because the older people were apparently healthy like those in the intervention group.

For both groups, their primary and secondary outcome measures were assessed at baseline (i.e., before the intervention program began) and posttest (i.e., after the intervention program ended). Covariate measures for both groups were assessed at baseline only. In addition, the therapist who provided intervention programs received standardized training to ensure intervention fidelity. Similarly, the outcome assessors received standardized training to ensure their agreement in assessments.

Primary outcomes

Quality of life (QoL). QoL was assessed using the WHOQOL-AGE.[22,23] The WHOQOL-AGE contains 13 items (e.g., "*How satisfied are you with your health?*") rated on a five-point Likert-type scale with a higher score indicating better QoL. The present study used the standardized WHOQOL-AGE summed score (i.e., adding the 13 item scores, then dividing by 13) to indicate the participants' QoL. The Taiwanese WHOQOL-AGE (with a written language in traditional Chinese characters) has been shown to have good psychometric properties (e.g., α=0.90).[24] In the present study, the WHOQOL-AGE had acceptable internal consistency (α=0.71 for baseline; =0.79 for posttest).

Wellbeing. Wellbeing was assessed using the Well-Being Scale for Elders (WBSE).[25] The WBSE contains nine items (e.g., "*I can control my life*") rated on a five-point Likert-type scale with a higher score indicating better wellbeing. The present study used the standardized WBSE summed score (i.e., adding the nine item scores, then dividing by nine) to indicate the participants' wellbeing. The Taiwanese WBSE version (with a written language in traditional Chinese characters) has been found to have good psychometric properties (e.g., α=0.91).[25] In

the present study, the WBSE had acceptable internal consistency (α=0.74 for baseline; =0.77 for posttest).

Secondary outcomes

Muscle strength. Upper limb and lower limb strength were assessed to monitor the participants' muscle strength during the study period. Upper limb strength was assessed using the grip strength test via the hand grips (BH Supplies; Model no. EH101). The participants were asked to do two grip strength trials using their dominant hands with a one-minute break between the two trials. The assessed strength tests were then averaged to indicate the participants' upper limb strength.

Lower limb strength was assessed using the 30 seconds sit to stand test.[26] Following the standard procedure of the 30 seconds sit to stand test, the participants were asked to sit in the middle of a chair with a straight back, arms crossed at the wrists against the chest, and feet apart a shoulder width. Then, the participants were asked to repeat standing up and sitting down within 30 seconds. The number of stands was counted and recorded. For both upper limb and lower limb strength, a higher test score indicates better muscle strength.

Balance. Dynamic balance of the participants was assessed. The participants were asked to complete the '8-foot up and go' test.[27] Following the standardized 30 seconds sit to stand test, participants were asked to stand up from a chair having armrests and walk to a target at a distance of eight feet, then turn around and return to the chair to sit down. The time spent in doing this task was recorded to indicate the participants' dynamic balance ability. Lower times indicate better balance.

Covariate measures

Demographics. The participants self-reported their demographics including their age (in years), sex (male or female), educational level (primary school or below, junior high school, or senior high school or above), height (in cm) and weight (in kg). Body mass index (BMI) was then

calculated using their self-reported height and weight (in kg/m^2).

Chronic disease and fall experiences. The participants self-reported whether they had any recent fall experience (yes or no) and the following chronic disease (yes or no): diabetes mellitus, hypertension, cardiovascular disease, arthritis, and/or osteoporosis.

Exercise habits and sleep duration. The participants self-reported their average sleep duration in the past week (in hours) and whether they engaged in the following exercise habits (yes or no): strolling, qigong (traditional Chinese exercises), and aerobic exercise.

Data analysis

All the analyses were performed using parametric statistics because the data were normally distributed based on the suggested cutoffs of skewness between -2 and 2, and kurtosis between -7 and 7 (skewness=-0.426 to 0.933; kurtosis=-0.513 to 2.201).[28,29] Independent *t*-tests (for continuous variables) and χ^2 tests (for categorical variables) were used to examine if the two groups had significant differences in their primary outcomes, secondary outcomes, and covariates at both baseline and posttest.

The intervention effects were examined using the following approaches: (i) whether the intervention group had significantly better improvements than the control group (i.e., posttest performance deducted from baseline performance) using independent *t*-tests; (ii) whether the intervention group had significantly better posttest performance than the control group after controlling the baseline performance and significant covariates using the analysis of covariance. Cohen's *d* was calculated for both approaches to evaluate the effect sizes (0.2 small effect; 0.5 medium effect; and 0.8 large effect) of the intervention program.[30] An effect size that is medium to large size could be interpreted as being clinically relevant. Pearson correlations were used to examine the associations between the health outcomes and demographic variables. Lastly, multiple linear regression models were constructed to examine the effects of the physical activity program on health outcomes. Moreover, analysis of covariance and regression models

were conducted to deal with the potentially significant differences in demographic information between the two groups. In addition, the analysis of covariance and regression models somewhat overcome the problem of ceiling effects in the baseline scores. Consequently, the effects of the treatment were comprehensively assessed.

Results

Two participants in the control group did not complete the posttest because they died during the study period (Figure 1). Table 1 reports the demographic information together with baseline and posttest performance in outcome measures for the both groups.

(Figure 1 and Table 1)

Table 2 shows the results regarding the effects of intervention on outcome performance. The results of the first statistical approach (i.e., comparing mean differences between baseline and posttest) indicated that the intervention group had significantly better performance than the control group in quality of life (Cohen's d=0.79; p<0.001), wellbeing (Cohen's d=0.51; p=0.002), lower limb strength (Cohen's d=0.56; p<0.001), and dynamic balance (Cohen's d=-1.15; p<0.001), but not upper limb strength (Cohen's d=0.03; p=0.861). Based on Cohen's d, the effects on quality of life, wellbeing, lower limb strength, and dynamic balance were clinically relevant. The results of the second statistical approach (i.e., using analysis of covariance) showed similar findings to the first statistical approach.

(Table 2)

The correlations between the demographic variables and the health outcomes are reported in Supplementary Table S1. The linear regression models further corroborated the results from the independent t-tests and analyses of covariance regarding the effects of the physical activity program on health outcomes. More specifically, the intervention group as compared to the control group had significantly better primary outcomes (Supplementary Table S2) and most

secondary outcomes after controlling the baseline primary outcome and demographic variables (Supplementary Table S3).

Discussion

Both hypotheses in the present study were supported, except for improvement in upper limb strength. In addition, the present study's findings provide a novel contribution to the literature that physical activity program could be incorporated into community LTC C-base centers in Taiwan, showing promising effects for health among older adults. Moreover, the program has the novelty of using board games based on concept of occupational therapy to motivate participants' engagement. To the best of the present authors' knowledge, there is no prior evidence has shown if a physical activity program could be incorporated into LTC C-base centers, and this is the first study to provide evidence reporting both feasibility and the beneficial effects of a physical activity program at an LTC C-base center.

The improvements in quality of life and wellbeing concur with prior findings.[16-18] A potential reason for the improvements is that the elevated physical fitness and functional ability (e.g., mobility) may help improve daily activities and independent living.[15,16] With elevated physical fitness levels and increased functional ability for independent living, older people are likely to feel empowered (e.g., they can handle their daily living errands without seeking others' help), which in turn, contributes to improved quality of life and wellbeing.[31,32] The high adherence in the present study (i.e., all participants in the intervention group did not miss any of the 24 sessions) is likely an additional reason for the quality of life/wellbeing improvement in this group. The high adherence shown in the present study also concurs with prior findings that older people are relatively adherent to exercise programs.[16] Therefore, the present findings suggest the feasibility of incorporating a physical activity program tailor-made for older people in LTC-C base centers in Taiwan.

The present study's findings also concur with prior research showing the efficacy of physical activity on physical fitness and functional abilities.[15,16] Because physical activity programs require older people to engage in aerobic and resistance activities, cardiovascular and musculoskeletal ability of these individuals can be strengthened.[33,34] Subsequently, older people's fitness and daily functions improve. However, contrary to expectation, there were no improvements in upper limb strength for the older people in the intervention group. This is perhaps unsurprising findings given that the physical activities performed did not focus on upper limb strength.

The present study's findings suggest several directions for future research. First, physical activity is beneficial for older people's daily living activities.[15,16] Therefore, future studies should examine to what extent the physical activity program incorporated in the LTC C-base center can improve older adults' daily living activities. Second, future studies should examine if daily living activities (e.g., social interaction) are important mediators for the physical activity program incorporated in LTC C-base centers that improve older adults' quality of life and wellbeing. Third, future studies should examine if physical activity program incorporated in LTC C-base centers can improve intrinsic capacity, a concept proposed by the World Health Organization, which involves a component of mobility to help older people successfully engage in activities.[1] More specifically, intrinsic capacity is defined as older adults' inner ability for them to maintain functional ability, healthy aging, quality of life, and wellbeing.[1] Additionally, the present findings suggest that physical activity programs should be routinely incorporated into the LTC C-base centers to maintain or improve older adults' health.

There are some limitations in the present study. First, the present study was not a randomized-controlled trial and had some biases due to the quasi-experimental deign. Second, the primary outcome measures relied on self-report data and may have been subject to social desirability bias. Third, the older people in the intervention group were not blinded (and could

not be blinded) because they obviously knew that they attended the physical activity program. Therefore, the improved scores might be biased by the Pygmalion effect,[35] because older people in the intervention group might have wanted to perform better to respond to the treatment effects. Fourth, the generalizability of the present findings might not be good because the infrastructure and facilities of LTC C-base centers differ between centers. It is unclear if the program used in the present LTC C-base center is equally feasible in other LTC C-base centers. Lastly, the present study did not assess long-term effects of the physical activity program.

Conclusion

The present study demonstrated that a physical activity program is feasible to be incorporated in the LTC C-base center under the LTC 2.0 policy in Taiwan. However, given that different LTC C-base centers may have different infrastructure and resources, additional evidence is needed for the Taiwan government to consider the potential of implementing a physical activity program for all LTC C-base centers.

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Ethics approval and consent to participate

Institutional Review Board, Human Research Ethics Committee of the Chung Shan Medical University Hospital (IRB: CSMUH No:CS1-21104).

Author contributions

Conceptualization: C-HL, M-DH, H-LC, C-YLin designed the study, analyzed and interpreted the data, and wrote the first draft of the manuscript; Data curation: C-YLaio, S-MT; Formal analysis: J-SC, C-YLin; Funding acquisition: C-HL, H-LC, C-YLin; Investigation: C-HL, H-LC, C-YLin; Methodology: M-DH, C-YLaio, S-MT, J-SC, MDG; Project administration: C-HL, H-LC, C-YLin; Resources: C-HL, H-LC, C-YLin; Software: C-HL, C-YLin; Supervision: C-YLin; Validation: C-HL, M-DH, C-YLaio, S-MT, J-SC, MDG, H-LC, C-YLin; Visualization: C-HL, C-YLin; Roles/Writing - original draft: C-HL, C-YLin; Writing - review & editing: M-DH, C-YLaio, S-MT, J-SC, MDG, H-LC, C-YLin.

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Figure legend.

Figure 1. Flow chart of the procedure.

Tables

Table 1. Comparisons between the two groups in demographics, baseline performance and posttest performance

	Mean (SD) or n (%)		*t* or χ^2 (*p*-value)
	Intervention group (N=75)	Control group (N=73)	
Demographics			
Age (years)	72.41 (5.81)	71.22 (4.72)	1.37 (0.173)
Sex (male)	8 (10.67)	17 (23.29)	4.20 (0.040)
Height (cm)	154.81 (6.38)	156.82 (7.81)	-1.72 (0.088)
Weight (kg)	56.73 (7.10)	56.74 (8.01)	-0.01 (0.996)
Body mass index (kg/m^2)	23.71 (2.88)	23.10 (2.91)	1.28 (0.201)
Education			22.31 (<0.001)
Primary school (or below)	49 (65.33)	38 (52.05)	
Junior high	11 (14.67)	33 (45.21)	
Senior high (or above)	15 (20.00)	2 (2.74)	
Chronic disease (Yes)	53 (70.67)	58 (79.45)	1.52 (0.217)
Diabetes mellitus (Yes)	12 (16.00)	14 (19.18)	0.26 (0.611)
Hypertension (Yes)	32 (42.67)	31 (42.47)	0.001 (0.980)
Cardiovascular disease (Yes)	16 (21.33)	15 (20.55)	0.01 (0.907)
Arthritis (Yes)	5 (6.67)	11 (15.07)	2.71 (0.100)
Osteoporosis (Yes)	10 (13.33)	12 (16.44)	0.28 (0.596)
Engaged in exercise (Yes)	73 (97.33)	64 (87.67)	5.02 (0.025)
Strolling (Yes)	60 (80.00)	53 (72.60)	1.12 (0.290)
Qigong (Yes)	9 (12.00)	13 (17.81)	0.99 (0.321)
Aerobic exercise (Yes)	21 (28.00)	15 (20.55)	1.12 (0.291)
Baseline performance			
Quality of life (1-5 scale)	3.43 (0.31)	3.41 (0.32)	0.56 (0.579)
Wellbeing (1-5 scale)	3.52 (0.36)	3.47 (0.36)	0.87 (0.388)
Upper limb strength (kg)	18.54 (4.93)	16.58 (3.90)	2.69 (0.008)
Lower limb strength (count)	16.06 (5.05)	14.64 (3.92)	1.91 (0.058)
Dynamic balance (second)	8.56 (2.57)	10.03 (2.53)	-3.49 (<0.001)
Posttest performance			
Quality of life (1-5 scale)	3.51 (0.33)	3.31 (0.31)	3.95 (<0.001)
Wellbeing (1-5 scale)	3.64 (0.35)	3.48 (0.35)	2.66 (0.009)
Upper limb strength (kg)	18.31 (4.97)	16.28 (3.86)	2.79 (0.006)
Lower limb strength (count)	17.21 (4.91)	14.26 (3.99)	4.02 (<0.001)
Dynamic balance (second)	7.31 (2.28)	10.42 (2.52)	-7.9 (<0.001)

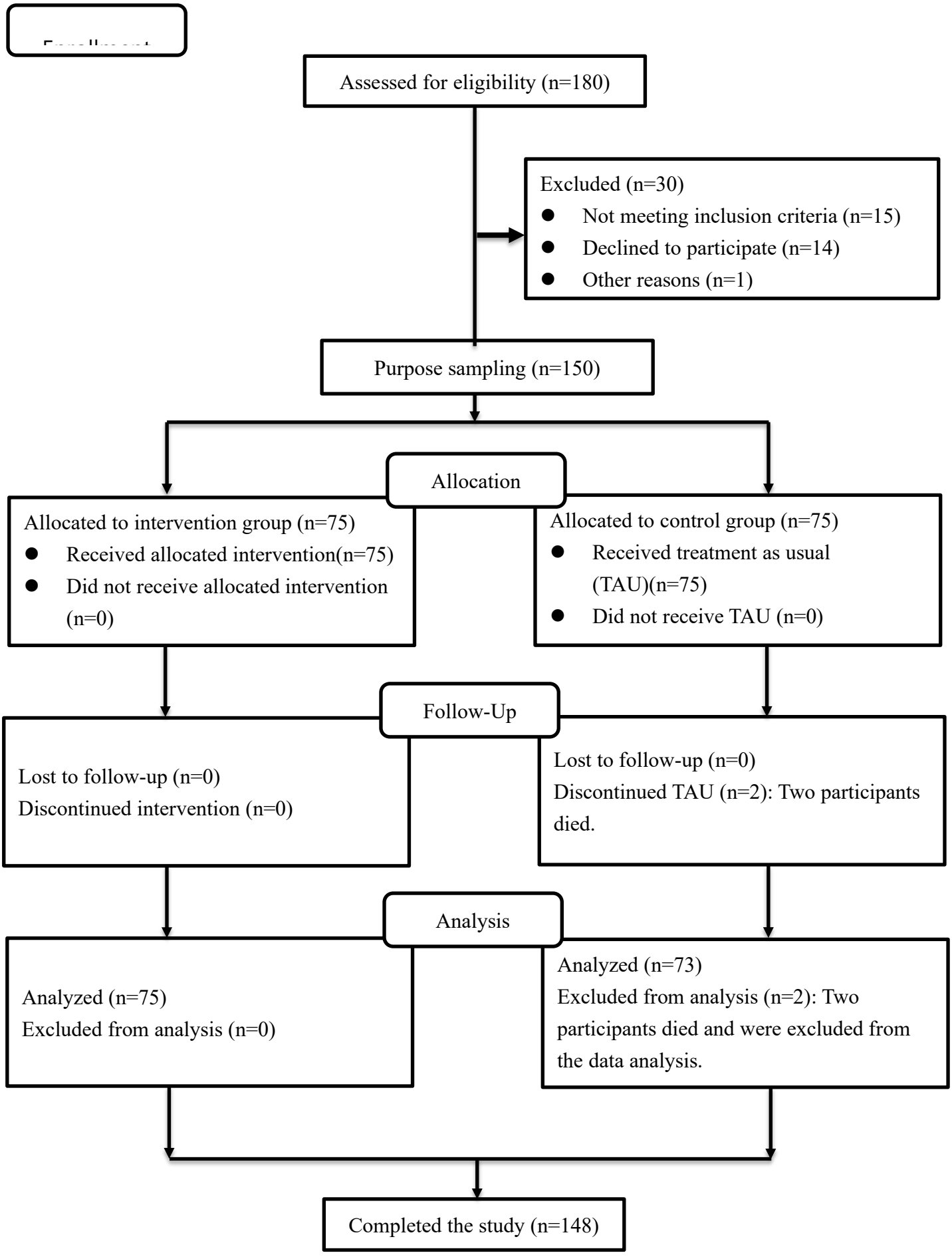
Table 2. Effects of intervention program on outcome performance

	Mean (SE)		*t* or F (*p*-value)	Cohen's *d*
	Intervention group	Control group		
Difference between baseline and posttest (T2-T1)[a]				
Primary outcomes				
Quality of life (1-5 scale)	0.08 (0.03)	-0.10 (0.03)	4.82 (<0.001)	0.79
Wellbeing (1-5 scale)	0.11 (0.02)	0.01 (0.02)	3.14 (0.002)	0.51
Secondary outcomes				
Upper limb strength (kg)	-0.23 (0.41)	-0.30 (0.12)	0.18 (0.861)	0.03
Lower limb strength (count)	1.15 (0.43)	-0.38 (0.13)	3.43 (<0.001)	0.56
Dynamic balance (second)	-1.26 (0.22)	0.39 (0.07)	-7.06 (<0.001)	-1.15
Analysis of covariance results[b]				
Primary outcomes				
Quality of life (1-5 scale)	3.54 (0.05)	3.37 (0.04)	19.23 (<0.001)	0.80
Wellbeing (1-5 scale)	3.56 (0.04)	3.46 (0.04)	7.59 (0.007)	0.47
Secondary outcomes				
Upper limb strength (kg)	17.72 (0.57)	17.61 (0.54)	0.06 (0.815)	0.04
Lower limb strength (count)	16.05 (0.60)	14.69 (0.57)	7.70 (0.006)	0.47
Dynamic balance (second)	8.53 (0.30)	10.51 (0.29)	64.57 (<0.001)	-1.36

Notes. T1=baseline; T2=posttest.

[a]Baseline and posttest outcome measure scores are presented in Table 1; independent *t*-tests were used. The outcome measure scores tested in the independent *t*-tests were differences between T1 and T2.

[b]Analysis of covariance controlled T1 outcome measures, sex, educational level, and exercise habit. The outcome measure scores tested in the analysis of covariance were posttest scores (i.e., T2). Moreover, sex, educational level, and exercise habits were controlled for because the two groups had significant differences in the three demographic variables at baseline. The two groups did not have significant differences in other demographic variables.


Assessed for eligibility (n=180)
Excluded (n=30)
Not meeting inclusion criteria (n=15)
Declined to participate (n=14)
Other reasons (n=1)
Purpose sampling (n=150)
Allocation
Allocated to intervention group (n=75)
Received allocated intervention(n=75)
Did not receive allocated intervention (n=0)
Allocated to control group (n=75)
Received treatment as usual (TAU)(n=75)
Did not receive TAU (n=0)
Follow-Up
Lost to follow-up (n=0)
Discontinued intervention (n=0)
Lost to follow-up (n=0)
Discontinued TAU (n=2): Two participants died.
Analysis
Analyzed (n=75)
Excluded from analysis (n=0)
Analyzed (n=73)
Excluded from analysis (n=2): Two participants died and were excluded from the data analysis.
Completed the study (n=148)