International Journal of Gerontology 13 (2019) 320–324
https://doi.org/10.6890/IJGE.201912_13(4).0011

International Journal of Gerontology

journal homepage: http://www.sgecm.org.tw/ijge/

Original Article

Promoting Physical Activity and Reducing Frailty of Middle-Aged and Older Adults in Community: The Effects of a Health Promotion Program Combining Smart Phone Learning and Exercise

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ARTICLE INFO

Accepted 5 December 2019

Keywords:
physical exercise,
frailty,
community health,
older adult,
smart phone

SUMMARY

Background: To intervene the health and frailty of middle-aged and older adults lived in community is an important subject for health-related professions as society fostering healthy aging. Engaging in proper physical activity and adequate usage of smart phone are beneficial. This study explored the effects of a health promotion program on enhancing heath and reducing frailty of middle-aged and older adults.
Methods: A quasi-experimental, two-group study design was conducted with purposive sampling of middle-aged and older adults from eight community care centers. The study period expanded from January to September, 2019. An intervention of smart phone learning and balance/flexibility exercise introduced to the experimental. A structural questionnaire used to collect pretest and posttest data: demographics; self-reported assessment of health, exercise, and frailty; measurement of handgrip and body mass. Descriptive and inferential statistical analyses were performed using SPSS 20.0.
Results: Completed dataset consisted of 93 subjects: 39 in experimental and 54 control. For within-group comparison, *exercise frequency* improved significantly ($p < .05$) in the experimental group. For between-group comparison, *exercise intensity* and *exercise duration* improved significantly at posttest. Furthermore, frailty measuring by Study of Osteoporotic Fracture (SOF) index reduced significantly for both within- and between-group comparisons.
Conclusion: The health promotion program combining smart phone learning of and the moderate exercise was effective to encourage physical activity and reduce frailty for middle-aged and older adults in community. The study could provide valuable information for future studies investigating healthy aging and frailty.

1. Introduction

A society with elderly population reaching 7% is considered an "*aging society*", and 14% an "*aged society*" as well as 20% a "*super-aged society*", according to the definition of the World Health Organization (WHO). The ageing population of Taiwan grows rapidly. In 2018, the elderly population of Taiwan reaches 3.3 million or 14.1% of its total population and the nation is officially an "*aged society*".[1] Faced with society rapidly ageing, to ascertain healthy ageing is a new challenge to society as a whole. Healthy ageing is a process of developing and maintaining the functional ability that enables well-being in older age.[2]

Frailty is prevalent as population growing into older age, frailty is a state of reduced ability to recover from adverse outcomes, and frailty is recognized as a risk factor for falls, disability, hospitalization, and mortality; however, frailty is generally considered reversible.[3–5] The syndrome of frailty includes lowered activity level, poor exercise tolerance, and loss of lean body and muscle mass.[6] Physical activity and exercise is beneficial to the health, function, and well-being of older adults and is also effective in managing frailty.[6–12] The general recommendations for exercise prescription in older adults include aerobic, muscle strengthening, and flexibility exercise.[7]

Various interventions are identified to prevent or reduce the level of frailty in community-dwelling older adults by a scoping review and early studies.[13–17] Effective interventions include physical exercise combined with nutrition consultation, cognitive training, and comprehensive geriatric assessment and management. The smart phone can also be useful to encourage physical activity and improve well-being for older adults.[18–22]

In order to facilitate healthy ageing in community, MacKay Memorial Hospital partnered with neighboring community care centers and develops a health promotion program combining physical activity and smart phone learning to combat frailty, to encourage exercise, and to promote community health. The study was aimed to explore the effects of this health promotion program on community-dwelling middle-aged and older adults in Taiwan.

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2. Methods and materials

2.1. Study design and settings

A quasi-experimental study design with experimental group and control was employed. With purposive sampling, we recruited participants of community-dwelling middle-aged and older adults from eight community care centers in Taipei City, the capital city of Taiwan. The eight community care centers were assigned equally to four centers as the experimental group and four centers as the control.

The study period occupied a period of eight months from January to September, 2019 with four recruiting periods. Each recruiting period expanded eight consecutive weeks and accepted a pair of community care centers as experimental and control group. During each recruiting period, a 16-hour intervention with 2-hour session per week was introduced solely to the experimental center while none was conducted in the control center. Each interventional session undertook a two-hour activity with 90 minutes dedicated to the learning of the usage and application of smart phone and 30 minutes to the practicing of balance/flexibility exercise. To encourage participation, gift vouchers were used as incentive.

The training material for balance/flexibility exercise was a 20-minute program called "Healthy Exercises for Seniors", which was produced by the government health promotion administration and available in multimedia format for online access (https://www.hpa.gov.tw/Pages/Detail.aspx?nodeid=1253&pid=8007). The program was designed to be free from limitations of location and to be easy to learn only with alternative movements of sitting and standing. The program should increase body movement and strengthen myodynamia and balance. In the training of smart phone, knowledge, skill, and experience of using graphics editing tools and social media and troubleshooting for fundamental equipment problems were exchanged during the 90-minute session. The training helped participants to get an access to the "Healthy Exercises for Seniors" program and to connect and involve with current social events as well as to enable them to create and share life events.

The inclusion criteria of participants were: 40 years old or above; clear in conscious; able to communicate (speak, read, and write) in Mandarin or Taiwanese; and, consented with the procedures of present study. The rationale of including participants younger than 65 years old was to support the evidence that early habitual exercise would have positive influences on health, well-being, and frailty for middle-aged and older adults. A structural questionnaire was developed and used in data collection. Pretest and posttest data were collected at the beginning and end of each recruiting period from experimental and control.

For ethic consideration, the study protocol of present study was approved by the Institution Review Board of MacKay Memorial Hospital (18MMHIS033e).

2.2. Measurement instrument

The structural questionnaire used by the study was designed specifically for the evaluation of health and frailty in older adults. The questionnaire was derived from an instrument used in previous study[23] with the removal of irrelevant items and the additional items for the frailty from the Study of Osteoporotic Fracture (SOF) index.[5] The questionnaire contained items for basic demographical characteristics and self-reported evaluation of health status, exercise, frailty, fall history, and well-being. For basic demographical characteristics, the information included gender, age, job condition, marital status, tobacco use, and alcohol consumption.

For self-reported evaluated variables, there were two items for health status, three items for exercise, three items for frailty from the SOF index, one item for falls history, and one item for well-being. The assessed values of all these items were self-reported. The health status items were *physical health* and *mental health*, which were rated in 5-point Likert scale (1 = very bad, 2 = bad, 3 = fair, 4 = good, 5 = very good). The three items of exercise were: *exercise frequency* (4-point, weekly exercise; 1 = zero, 2 = 1~2 days, 3 = 3~4 days, 4 = 5~7 days); *exercise intensity* (5-point; 1 = none, 2 = sweaty and gasping, 3 = sweaty only, 4 = gasping only, 5 = neither sweaty nor gasping); and, *exercise duration* (4-point; 1 = none, 2 = below 30 minutes, 3 = 30~60 minutes, 4 = over 1 hour). The items of SOF index were similar to original version but suitable for use in the clinical settings with one year backtrack of weight loss and one week backtrack of energy level. The falls history item asked if the respondent had experienced falls twice in the past year (1 = yes, 0 = no). The well-being item inquired respondent's life satisfaction (5-point; 1 = very bad, 2 = bad, 3 = fair, 4 = good, 5 = very good).

In addition to the demographical characteristics and the self-reported items, body mass index (BMI) and handgrip strength were recorded in the questionnaire. BMI and handgrip strength were measured using the equipments which were supported and maintained by the medical center. For measuring BMI, height and weight scale was used. For handgrip strength measurement, the dynamometer was used and measurement steps were explained and demonstrated first prior to actual measurement.

2.3. Statistical analysis

For statistical analysis, the software package, IBM SPSS version 21.0, was used to perform the descriptive and inferential statistical analyses. The raw data of self-reported health status and exercise were re-coded prior to data analysis. The statistical methods included means, standard deviation, Pearson's and McNemar's Chi-Square test, and *t* test. The level of significance, α level, was preset to .05.

3. Results

A total of 93 participants with 39 in the experimental group and 54 in the control group were accumulated with complete pretest and posttest data over the four recruiting periods.

3.1. Characteristics of the participants

The characteristics of the participants were summarized in Table 1. The sample as a whole was attributed by: majority in women (n = 68; 73.1%), age 65 years old or above (n = 65; 69.9%), none in tobacco use (n = 92; 98.9%), and none in alcohol consumption (n = 90; 96.8%); fewer participants were employed (n = 10; 10.8%); and, the number of married participants (n = 43; 46.2%) and unmarried (n = 50; 53.8%) were about equal.

The profiles of experimental and control groups were comparable and similar in all demographical characteristics in gender, age, job condition, marital status, tobacco use, and alcohol consumption as shown by the Chi-square tests.

3.2. Baseline differences between experimental and control groups

The pretest responses of the experimental and control groups

were summarized in Table 2. The sample as a whole was attributed: fair health (*physical health* = 3.46 and *mental health* = 3.75), habitual and mild exercise (*exercise frequency* = 2.56, *exercise intensity* = 1.61, and *exercise duration* = 2.53), pre-frailty (SOF score = .66), fewer experience in *fall history* (yes = 11.8%), fair *life satisfaction* (M = .73), marginal overweight (BMI = 25.99), and weak in handgrip strength (M = 22.20).

Testing the difference between the baseline data of experimental and control groups indicated that the subsamples of the two groups were comparable and equally distributed in all variables: *physical health*, *mental health*, *exercise frequency*, *exercise intensity*, *exercise duration*, SOF score, *falls history*, *life satisfaction*, BMI, and handgrip strength.

3.3. Within-group difference between baseline and posttest

The within-group differences between baseline and posttest were summarized in Table 3. Testing the differences between baseline and posttest within the experimental group indicated that *exercise frequency* (M = 2.54 vs. 3.26) and SOF score (M = .51 vs. .26) were improved significant with the introduction of the intervention while *mental health* (M = 3.82 vs. 4.08) marginally significant and non-significant for the rest of variables: *physical health*, *exercise intensity*, *exercise duration*, *falls history*, *life satisfaction*, BMI, and handgrip strength.

Testing the differences between baseline and posttest within the control group indicated that none of the changes were significant and all variables were statistically comparable and similar: *physical health*, *mental health*, *exercise frequency*, *exercise intensity*, *exercise duration*, SOF score, *falls history*, *life satisfaction*, BMI, and handgrip strength.

3.4. Posttest differences between experimental and control groups

The posttest responses of the experimental and control groups were summarized in Table 4. The profile of the posttest responses as a whole was similar to the pretest with minor improvement in *physical health* (M = 3.56), *mental health* (M = 3.85), *exercise frequency* (M = 2.94), *exercise intensity* (M = 1.65), *exercise duration* (M = 2.60), SOF score (M = .57), *falls history* (13%), *life satisfaction* (M = .73), and BMI (M = 24.99).

Testing the differences between the experimental and control groups indicated that: *exercise intensity* (M = 1.82 vs. 1.52), *exercise duration* (M = 2.74 vs. 2.50), and SOF score (M = .26 vs. .80) were significantly improved in experimental group over the control; several variables although improved but non-significant: *mental health* (M = 4.08 vs. 3.72), *physical health* (M = 3.72 vs. 3.44), *exercise frequency* (M = 3.26 vs. 2.70), *falls history* (yes = 12.8% vs. 14.8%), *life satisfaction* (M = 3.92 vs. 3.57), BMI (M = 24.51 vs. 24.82), and handgrip strength (M = 23.30 vs. 21.28).

4. Discussion

This was a community-based study on physical activity and frailty in middle-aged and older adults to further understanding the subject of healthy ageing. We investigated the effects of an intervention on reversing frailty and improving health. The results indicated that the intervention was indeed effective on the responses

Table 1
Characteristics of the participants.

Characteristics	All (N = 93)		Experiment (N = 39)		Control (N = 54)		χ^2	*p*
	n	%	n	%	n	%		
Gender							.49	.48
Male	25	26.9	9	23.1	16	29.6		
Female	68	73.1	30	76.9	38	70.4		
Age							.06	.97
< 50 years	2	2.2	1	2.6	1	1.9		
50~64 years	26	28.0	11	28.2	15	27.8		
≥ 65 years	65	69.9	27	69.2	38	70.4		
Job condition							3.94	.14
Employed	10	10.8	6	15.4	4	7.4		
Housekeeping	39	41.9	12	30.8	27	50.0		
Retired	44	47.3	21	53.8	23	42.6		
Marital status							.00	.99
Married or couple	43	46.2	18	46.2	25	46.3		
Single/unmarried/widow	50	53.8	21	53.8	29	53.7		
Tobacco use[1]							.73	.39
None	92	98.9	39	100	53	98.1		
< 10	1	1.1	0	0	1	1.9		
Alcohol consumption[2]							1.46	.48
None	90	96.8	37	94.9	53	98.1		
1~2 days	2	2.2	1	2.6	1	1.9		
3~4 days	1	1.1	1	2.6	0	0		

Notes: [1] Number of cigarette per day; [2] Number of drinking day per week.

Table 2
Baseline differences between experimental and control groups.

Variables	Total (N = 93)[#]	Experiment (N = 39)[#]	Control (N = 54)[#]	F/χ^2	*p*
Health status					
Physical health	3.62 ± .81	3.35 ± .76	3.46 ± .79	.05	.83
Mental health	3.82 ± .76	3.70 ± .74	3.75 ± .75	.07	.79
Exercise					
Exercise frequency	2.54 ± 1.02	2.57 ± 1.06	2.56 ± 1.04	.10	.75
Exercise intensity	1.67 ± .70	1.57 ± .79	1.61 ± .75	1.54	.22
Exercise duration	2.54 ± .79	2.52 ± .72	2.53 ± .75	.35	.56
Frailty					
SOF score	.51 ± .76	.76 ± .70	.66 ± .73	1.36	.25
Falls history					
Falls history				.06	.80
No	34 (87.2)	48 (88.9)	82 (88.2)		
Yes	5 (12.8)	6 (11.1)	11 (11.8)		
Well-being					
Life satisfaction	3.79 ± .70	3.67 ± .75	3.72 ± .73	.73	.40
Body measurement					
BMI	24.48 ± 4.92	27.07 ± 17.42	25.99 ± 13.65	.73	.40
Handgrip strength	22.45 ± 8.09	22.03 ± 7.94	22.20 ± 7.96	.00	1.00

Notes: SOF: the Study of Osteoporotic Fracture index; BMI: body mass index. [#] Mean ± SD or N (%).

Table 3
Within-group difference between baseline and posttest.

Variables	Experimental group (N = 39)		*t*	*p*	Control group (N = 54)		*t*	*p*
	Baseline[#]	Posttest[#]			Baseline[#]	Posttest[#]		
Health status								
Physical health	3.62 ± .81	3.72 ± .89	.58	.56	3.35 ± .76	3.44 ± .69	.90	.37
Mental health	3.82 ± .76	4.08 ± .62	1.96	.05	3.70 ± .74	3.72 ± .71	.18	.85
Exercise								
Exercise frequency	2.54 ± 1.02	3.26 ± .94	5.05	.00	2.57 ± 1.06	2.70 ± 1.08	1.63	.11
Exercise intensity	1.67 ± .70	1.82 ± .45	1.53	.14	1.57 ± .79	1.52 ± .77	-.54	.59
Exercise duration	2.54 ± .79	2.74 ± .68	1.39	.17	2.52 ± .72	2.50 ± .97	-.17	.87
Frailty								
SOF score	.51 ± .76	.26 ± .50	-2.24	.03	.76 ± .70	.80 ± .83	.31	.76
Falls history								
Falls history[§]				1.0				.69
No	34 (87.2)	34 (87.2)			48 (88.9)	46 (85.2)		
Yes	5 (12.8)	5 (12.8)			6 (11.1)	8 (14.8)		
Well-being								
Life satisfaction	3.79 ± .70	3.92 ± .87	.78	.44	3.67 ± .75	3.57 ± .86	-.78	.44
Body measurement								
BMI	24.48 ± 4.92	24.51 ± 5.23	.11	.91	27.07 ± 17.42	24.82 ± 3.53	-.78	.44
Handgrip strength	22.45 ± 8.09	23.30 ± 8.34	1.32	.20	22.03 ± 7.94	21.28 ± 8.47	-.78	.44

Notes: SOF: the Study of Osteoporotic Fracture index; BMI: body mass index. [#] Mean ± SD or N (%); [§] McNemar's test.

Table 4
Posttest differences between experimental and control groups.

Variables	Total (N = 93)[#]	Experiment (N = 39)[#]	Control (N = 54)[#]	F/χ^2	*p*
Health status					
Physical health	3.56 ± .79	3.72 ± .89	3.44 ± .69	.68	.41
Mental health	3.87 ± .70	4.08 ± .62	3.72 ± .71	4.05	.05
Exercise					
Exercise frequency	2.94 ± 1.05	3.26 ± .94	2.70 ± 1.08	.59	.45
Exercise intensity	1.65 ± .67	1.82 ± .45	1.52 ± .77	21.55	.00
Exercise duration	2.60 ± .86	2.74 ± .68	2.50 ± .97	9.51	.00
Frailty					
SOF score	.57 ± .76	.26 ± .50	.80 ± .83	15.48	.00
Falls history					
Falls history				.07	.78
No	80 (86.0)	34 (87.2)	46 (85.2)		
Yes	13 (14.0)	5 (12.8)	8 (14.8)		
Well-being					
Life satisfaction	3.72 ± .88	3.92 ± .87	3.57 ± .86	.91	.34
Body measurement					
BMI	24.69 ± 4.30	24.51 ± 5.23	24.82 ± 3.53	1.52	.22
Handgrip strength	22.12 ± 8.43	23.30 ± 8.34	21.28 ± 8.47	.00	.97

Notes: SOF: the Study of Osteoporotic Fracture index; BMI: body mass index. [#] Mean ± SD or N (%).

of self-reported variables in exercise and the SOF scores among middle-aged and older adults from eight community care centers.

Examining the demographic profile of the present study revealed that the study sample were in majority of women with the mean age between sixty and seventy years old, a good representative of community-dwelling older adults.[11] Aged women have greater vulnerability to frailty via intrinsic risk of losing lean body mass and via extrinsic effects on sarcopenia.[3] The management of frailty is critical to the health and well-being of aged female population.

The design of the health promotion program used in this study was derived from previous study,[23] which focusing on healthy behaviors in community; the response in *mental health* of the present study hence expected to be comparable. Furthermore, it was theorized that the release of endorphins inducing by physical exercise might trigger psychological pleasure and attribute to the increased *mental health*.

The effect on lowering the SOF scores observed in the experimental group could be attributed to the physical exercise introduced in the intervention. As demonstrated by early studies and reviews,[13,14,16] the intervention of physical exercise attributes the reversal of frailty. The finding of this study mounted additional evidence for the effect of physical exercise on reducing frailty. In contrast to these studies though, we employed a sample of mixed frailty including robust participants, hence, it could mitigate the effects of physical exercise in reducing frailty.

It was considered unethical and disadvantage without giving something that would benefit the health of participants in the control groups for the present study. Therefore, the study had considered to compensate the disadvantage by providing identical program to the community care centers allocated as the control group after the study period when resources and opportunities were permitted.

5. Conclusion and suggestions

As aged population in the society grows in rapid pace, health services need to reverse or reduce the capacity decline, the environ-

ment of community needs to promote capacity-enhancing behaviors to ascertain healthy aging for the decreased capacity subpopulation in the society. Frailty has serious consequence and it generally can predict falls, disability, hospitalization, and mortality. Fortunately, frailty is reversible under certain conditions. Physical exercise with mounted evidence can improve health and reduce frailty. The results of this study demonstrated the effects of the community-based health promotion program on reducing frailty among middle-aged and older adults. With the findings of this study, it should be able to provide valuable information for future studies in healthy ageing to healthcare professions.

Several features of this study limited the generalization of its findings that should be cautious. Firstly, our sample of middle-aged and older adults was relatively healthy. Secondly, we used community center as the unit for group allocation to either experimental group or control; the intervention was tailored for group practice. Thirdly, we only monitored the short-term effects of the intervention in eight weeks therefore long-term effect was yet determined.

According to the WHO, elderly population should maintain regular and routine physical activity at least 150 minutes per week to improve body balance and to mitigate the risks of frailty. For policy making, the cost-effectiveness of keeping an interventional program long-term operational required further evaluation. Future studies on health promotion for community-dwelling middle-aged or older adults should focus on in-depth as well as comprehensive explorations.

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