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Effects of Multicomponent Exercise Prescription on Cognitive and Functional Fitness for Frailty Syndrome

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Abstract:

Purpose: *The purpose of this study was to investigate the effects of a multicomponent exercise on cognitive and functional fitness for Frailty Syndrome.*

Methods: *This study applied a pre-experimental design and conducted a one-group pretest-posttest experimental design. Participants were 20 volunteer older adults with a frailty syndrome (above 65 years old) enrolled in multicomponent exercise prescription program at senior center. The study was implemented during a 12- week period. The pretest was administered during the first week. A multicomponent exercise core program for frail elder's training in this study was adopted from American College of Sports Medicine (ACSM). The core program principles and training method were included: Warm-up and Cool-down, Flexibility training, Resistance training, Aerobic endurance training, Balance and mobility training. Participants completed a multicomponent physical fitness program, the effects on cognitive and functional fitness of learning outcome were examined across posttest.*

Results: *The results revealed that the model of multidimensional exercise program on performance program is significant effects for frailty. The results of this study lend support to others who indicate that exercise prescription positively affects frail adults' cognitive and functional fitness.*

Conclusion: *The result of this study indicated that the positive effects of the 12-week multicomponent training course improved the cognitive and functional fitness. The implications for effects of multicomponent fitness prescription on task performance program to promote frail adults on cognitive and functional fitness and future research are discussed.*

Key words: *Multicomponent Fitness, Frailty Syndrome, Cognitive, Functional Fitness*

1. Introduction

In recent years, the issue of frailty syndrome is becoming increasingly important as the population of older adults grows (Zhang, N, Zhu, W. L., Chen, W., 2019; Jackson, Sapey, Lord, 2017).Frailty in older adults refers to the loss of some functional abilities(Fried, Tangen, Walston, et al.,2001). However, frailty is not synonymous with disability. Frailty can be seen as the risk of instability and loss of function as brought about by the functional degradation of various body systems(Angulo, El Assar , Rodríguez-Mañas,2016; Ruan, Yu, Chen, Bao, &He,2015). Frailty can also be seen as a biological syndrome that includes a reduced level of resistance in the face of multiple sources of pressure due to a decline in physiological and psychological functions (Keevil, Romero-Ortuno,2015). Frailty is a geriatric syndrome that affects multiple domains of human functioning. A variety of problems contributes to the development of this syndrome; three key components includingsarcopenia, cognitive impairment, such as Alzheimer disease, and poor nutritional status were an important determinant of this condition (Heath, & Stuart, 2002; Laura Lorenzo-López, et al., 2016; Sayer, et al, 2008). Therefore, many forms of frailty exist, including functional, medical, intellectual and psychological, and physiological frailty.

Considering that older adults form the population's fastest-growing age group, and also that a considerable proportion of this group will be frail individuals in the future, it can thus be inferred that the frailty problem will grow in severity going forward (Huang, & Wang, 2018; Wojtek, &Chodzko-Zajko, 2015). Frailty has been described as a dominant characteristic that can be observed via five dimensions, namely, unintentional weight loss, self-reported exhaustion, low levels of physical activity, slowness, and weakness. An individual who exhibits three or more of these five symptoms may be considered to be suffering from frailty. Using this definition, about 7% of older adults aged 65 years and above meet the criteria for this definition (Bortz, 2002; Fried, Tangen, Walston, et al.,2001; Heath, & Stuart, 2002). A frail adult often has to deal with one or more disabilities (such as auditory and visual impairments) which can affect his or her ability to perform the activities of daily living. However, exercise and physical activities can improve the physical functions of older adults and thereby help to prevent and/or reduce their frailty (Lorenzo-López, 2017).

The effects of physical fitnesswere one of the key reasons that affect health. Lack of physical activity will increase mortality and morbidity of elderly (Perracini, Franco, Ricci, & Blake, 2017).Many studies have examined the benefits of exercise in frail elders living in skilled nursing facilities, where it is convenient to conduct and assess the effect of group-centered interventions(Wojtek, &Chodzko-Zajko, 2015). These institutionalized populations, who often have varying degrees of cognitive impairment, can be challenging both when trying to establish motivation for exercise and when creating opportunities for group reinforcement and participation. Study variables on which exercise interventions have had an impact include those directly related to the exercise itself changes in mobility or strength.

The development of effective model on prescribing exercise that seek to optimize the processing of new learning strategies is an essential issue of for frail elder instruction. Traditional instructional design to exercise programming for frail elders have generally focused on single training for improving functional physical fitness. Although these goals may be appropriate for some benefits for older adults, alternative goals may be helpful to accommodate the needs of older adults with more diverse levels of health combined with cognitive function, there are few research-based guidelines delving into prescribing exercise which enhance on depth of effective multicomponent exerciseon learning outcome. This study aimed to investigate the effects of a multicomponent exercise on cognitive and functional fitness among the elderly on frailty.

2. METHODS

2.1. Participants

Participants in this study were recruited from our volunteer databases, which included elderly individuals (65 years and over). The inclusion criteria we used were dwelling in the community and being 65 years or age or older. 25 prospective participants with a Clinical Frailty Rating (Fried, et. al., 2001)including 20 pre-frail and 5frailenrolled in a multicomponent prescription program. For random reasons (illness, 30 percentage absent, not finished test) were not available for 5 subjects. The final analysis was performed on a sample of 20 volunteer participants（age: 79.77±7.06、height: 154.9±9.3、weight: 55.5±7.25.

2.2. Intervention

Participants in the multicomponent exercise group exercised under the supervision of senior physical education professor and physiotherapists for 90 min/d, 2 d/wk, during the 12 weeks. Two senior physical education professor and one physiotherapists involved in geriatric rehabilitation and three well-trained instructors conducted each intervention. The exercise prescriptions for frail older adults should be designed to suit individual abilities and preferences. The three primary objectives of exercise prescriptions for frail older adults are as follows: increased muscle strength, increased cardiovascular endurance, and increased overall physical activity and energy expenditure (ACSM, 2016; Wojtek, &Chodzko-Zajko, 2015).

A multicomponent exercise core program for frail elder’s training in this study was adopted fromAmerican College of Sports Medicine. (ACSMS, 2016) and Physical activity instruction of older adults (Jones & Rose, 2005). The core program principles and training method were included: Warm-up and Cool-down, Flexibility training, Resistance training, Aerobic endurance training, Balance and mobility training.It would also be helpful if an individual's activities of daily living and his or balance can be improved via his or her involvement other exercise programs. For the cognitive training factor, the design of the intelligent board hardware, a group exercise intervention tool, included a 4M*1.8M artificial grass field for physical activities. The various shapes, colors, lines, and numbers on the surface corresponded to cognitive science functions and conformed with requirements regarding older adults' safety, tactile sensations, interactions, and ergonomics (Huang, Wang, & Lin, 2016).

For the risk management and issues, the physiotherapists and well-trained instructors provided ongoing safety monitoring to prevent adverse accidents such as falling during the program.It is especially important to avoid exhaustion, which is a negative reinforcement to exercise(ACSM, 2016). After an exercise regimen has been incorporated into the patient's routine, heart rate monitoring can provide the patient and involved care givers feedback about exercise intensity.

In the absence of cardiac or respiratory symptoms, a maximum heart rate of 60% to 75% of the predicted maximum heart rate should be set as a ceiling. In this study, the training program for frail adults was adopted recent guidelines suggest that for patients planning low-intensity exercise, heart rates remain below 60% of the predicted maximal rate (220 beats per minute minus the patient's age), the physician can use clinical judgment to recommend an exercise stress test (ACSM, 2016; Wojtek, &Chodzko-Zajko, 2015). For the well design for training program, daily home-based exercise in addition to structured program and outdoor walking was recommended to the participants.

2.3. Data Collection and Analysis

Data analysis were applied to each of the dependent variables. A t-test was use for pre –post one group experimental design. After participants completed 10 weeks of training program, a post-test was delivered. The material as measurement on cognitive function for participations was a Mini Mental State Examination, MMSE (Folstein, Folstein, & McHugh, 1975). The MMSE is also recommended by the National Institute for Health and Clinical Excellence (NICE) as a standard tool for dementia screening. The MMSE score indicates the severity of dementia, and the maximum score is 30 points.

The scale consists of 11 items and 30 answers, with 1 point given for each correct answer. A score of 24-30 points indicates intact cognitive functions; a score of 18-23 points indicates MCI; a score of 0-17 points indicates severe cognitive impairment. The 11 items of the scale include five constructs, namely, orientation, registration, attention and calculation, recall, and language. Their content examines conceptions of current time and place, the repetition of words, simple mathematical calculations, and language use and understanding. The MMSE also evaluates visual-construction skills (Folsteing et al., 1975). The sample inclusion criteria in this study included an MMSE score of 18-23 points indicating MCI.

In addition, the function fitness evaluation was adopted from Senior Fitness Test, SFT (Rikli& Jones, 2001). The function fitness evaluation included 30s chair-stand test, 30s one-arm curl test, chair sit-and-reach test, back-scratch test, 2.44 meters up-and-go test, 2-min step test, and grips strength.Calculations were made using the Statistical Package for the Social Sciences(SPSS). All tests of significance adopted an alpha level of .05.

3. Results

3.1. Data of Participants

This study recruited 25 participants. Older adults who did not have frailty syndrome, had an attendance rate that was lower than 70%, or did not complete the entire test were excluded from the sample after the 12 weeks multicomponent training course. The final sample included 20 participants. Table 1 shows the results of the basic data survey. With regard to gender, most of the 11participants were female (73.3%), while 4 participants (26.7%) were male. The average age was 71.76±7.06 years. The average height was 152.9±9.2 cm. The average weight was 55.4±7.24 kg.

Table1. *Participants' basic data*

Gender	Number		Percentage	
Male	6		30.0%	
Female	14		70.0%	
Variable	Mean	SD	Max.	Min.
Age (years)	79.77	7.06	62	92
Height (cm)	154.9	9.2	178	140
Weight (kg)	55.5	7.24	45	67.2

3.2. Intervention on Cognitive Functions

Table 2indicated that the results the total MMSE score was 18.27±3.327 before the intervention and 22.93±3.945 after the intervention. The average score increased from 17.07 before the intervention to 21.93 after the intervention, reaching a significant difference (p=.001 , $p < .05$). The results also showed that each part of cognitive function regarding changes in time orientation, spatial orientation, three-character word registration, attention and calculation, short-term memory, ability to recall names, repetition, understanding, reading, writing, drawing, and total MMSE scores after the multicomponent course intervention.

1) With regard to time orientation, its values were 2.70±1.468 and 3.63±1.552 before and after the intervention, respectively. The average values of the time orientation sense were 2.80 and 3.53d before and after the intervention, respectively. However, the before and after results were reached significantly different (p=.042 , $p < 0.5$).
2) The value for spatial orientation was 4.83±.799 before the intervention and 5±.000 after the intervention. Its average values were 4.73 and 5.00 before and after the intervention, respectively. However, the before and after results were not significantly different (p=.227 , $p > 0.5$).
3) With regard to the repetition of three-character words, the value was 2.97±.352 both before and after the intervention, and the average value did not change. The before and after results were not significantly different (p=1 , $p > 0.5$).
4) The attention and calculation score was .94±1.544 points before the intervention and 1.53±1.959 points after the intervention. The average scores were .93 and 1.53 before and after the intervention, respectively. However, the before and after results were not significantly different (p=.238 , $p > 0.5$).
5) The short-term memory score was .41±.747 before the intervention and 2.43±1.123 after the intervention. The average scores were .40 and 2.43 before and after the intervention, respectively, reaching a significant difference (p=.000 , $p < 0.5$).
6) With regard to understanding, the score both before and after the intervention was .28±.468. The average score increased from 1.77 before the intervention to 2.80 after the intervention, reaching a significant difference (p=.002 , $p < 0.5$).
7) The reading score was .27±.468 before the intervention and .27±.468 after the intervention., and the average reading score did not change. The before and after results were not significantly different (p=1 , $p > 0.5$).
8) The writing score was .08±.278 before the intervention and .28±.468 after the intervention. The average score increased from .07 before the intervention to .27 after the intervention. However, the before and after results were not significantly different (p=.082 , $p > 0.5$).
9) The drawing score before and after the intervention was .34±.498 and .48±.526, respectively. The average score increased from .33 before the intervention to .47 after the intervention. However, the before and after results were not significantly different (p=.556 , $p > 0.5$).
10) The average scores for the ability to recall names and repetition did not change, and thus did not reach a statistically significant difference.

The statistical results indicated a significant change in the participants' MMSE total scores, time orientation, short-term memory, and understanding were reached a significantly different. However, in their scores on the before and after results including time orientation, spatial orientation, attention and calculation, writing, and drawing were not significantly different

Table2. *Changes in MMSE scores*

Variable	Before Intervention	After Intervention	t-value	*p*-value
Time orientation	2.70±1.468	3.63±1.552	-2.028	.042*
Spatial orientation	4.83±.799	5.00±.000	-1.293	.227
Three-character word registration	2.97±.352	2.97±.362	.000	1
Attention and calculation	.94±1.544	1.63±1.969	-1.270	.238
Short-term memory	.40±.747	2.43±1.123	-6.808	.000***
Understanding	1.67±.986	2.80±.414	-3.900	.002**
Reading	.27±.468	.27±.468	.000	1
Writing	.08±.278	.28±.468	-1.881	.082
Drawing	.34±.498	.48±.526	-.619	.546
Total	18.27±3.327	22.93±3.945	-4.172	.001**

3.3. Intervention on Functional fitness

The statistical results on Table 3 indicated a significant increase ($p < .001$) in the participants' functional fitness scores. The result revealed that the functional physical fitness on shoulder flexibility and cardio respiratory endurance, lower muscles strengths, and mobility reached a significantly different.

Table3. *Effects on functional fitness*

Fitness	Time	M	SD	*t*	*p*
shoulder flexibility	Before	-13.64	10.38	-5.49***	.00
	After	-9.66	9.03		
cardiorespiratory endurance	Before	101.26	7.29	-5.37***	.00
	After	145.45	6.63		
muscles strength	Before	15.70	2.87	-2.86***	.00
	After	17.53	2.66		
mobility	Before	10.21	1.91	3.99***	.00
	After	9.33	1.21		

N=15, ***$p < .001$

4. DISCUSSION

The purpose of this study was to examined the effects of a multicomponent exercise on cognitive function and functional fitness among the frail elderly. This study used multicomponent exercise prescription and applied a totally well instructional design model for frail elders. Twelve weeks of multicomponent exercise improved cognitive function in older adults with frailty syndrome. In particular, positive effects were participants' MMSE total scores, time orientation, short-term memory, and understanding were reached a significantly different. In addition, the result revealed that the functional physical fitness on shoulder flexibility and cardiorespiratory endurance, lower muscles strengths, and mobility reached a significantly increases.

Frailty is a geriatric syndrome that affects multiple domains of human functioning. A variety of problems contributes to the development of this syndrome; three key components includingsarcopenia, cognitive impairment, such as Alzheimer disease, and poor nutritional status were an important determinant of this condition (Heath, & Stuart, 2002; Laura Lorenzo-López, et al., 2016; Sayer, et al, 2008).

The results of this study lend support to others who indicate that exercise prescription positively affects frail elders' cognitive and functional fitness (Erickson, *et al.*,2012; *Suzuki, et al., 2017;* Smith, et al. 2010*)*.A retrospective review study revealed that aerobic exercises combined with double-task training or stretching exercises improved cognitive and motor functions in adults with MCI or early Alzheimer's disease (Chu, 2012). This study also is consistent with findings thatexercise improve attention, executive function, and memory and that both aerobic exercise and resistance training are important for the maintenance of cognitive and brain health in older adults (Smith et al., 2010; Voss et al., 2011; Wilson, Jackson, Sapey, &Lord,2017). The results of this study was revealed that a multicomponent exercise may provide an effective way on cognitive function and functional fitness among the frail elderly.

A more comprehensive design can improve all-round cognitive functions and fitness of frail elders and delay their degeneration(Lautenschlager, Cox, Flicke, et al, 2008).Thus, drawing from past research, this study developed amulticomponent exercise and totally well instructional design model of prescribing exercise for frail elders may improve the physical functions of older adults and thereby help to promote cognitive function on their frailty.

5. Conclusion And Suggestions

The issue of frailty syndrome is becoming increasingly important as the population of older adults grows. Frailty can also be seen as a biological syndrome that includes a reduced level of resistance in the face of multiple sources of pressure due to a decline in physiological and psychological functions. A multicomponent exercise program on performance effectively improves cognitive functions and promote the functional fitness. Furthermore, the results in this study indicated that twelve weeks of multicomponent exercise improved cognitive function on the MMSE total scoresamong older adults with frailty syndrome. In particular, positive effects weretime orientation, short-term memory, and understanding were reached a significantly different. In addition, the result revealed that the functional physical fitness on shoulder flexibility and cardio respiratory endurance, lower muscles strengths, and mobility reached a significantly increases. This study indicates that multicomponent exercise on dual-task performance can improve the functions fitness of older adults and thereby help to prevent or reduce their frailty.

In addition, the design of the course, a totally well instructional design model of prescribing exerciseas developed in this study for such patientswith frailty syndrome, included cognitive function training stimulating working memory, attention distribution, and the ability to plan. The result of this study indicated that the positive effects of the 12-week multicomponent training course improved the cognitive functions and fitness.

This study has some implications for those who design instruction for frail elders. The effects of thetotally well instructional design model of prescribing exercise on multicomponent training program can successfully increase frail elder performance and motivation. According the past study, some of the studieswere originally designed for one way’s function among instructional settings. The current study suggests that the multicomponent training program can be used with instructional activities for frail elders. An application of designers should evaluate frail elder’s characteristics, for example, ability, different age group with decline in physiological and psychological functions when assigning learners to instructional environment to accomplish goals.

Future studies should examine the relatively short duration of the treatment and the effect of instructional control may have influenced the outcomes. Extending the experimental time for overall instruction could produce different results for effective and performance. Further research should identify critical elements on cognitive function and fitness under which effective exercise prescription can be generated and maintained on the domain of functional training setting for frail elders. No control group was established in this study. Future studies should also establish a control group in order to observe its performance and analyze differences before and after multicomponent training.A future follow-up investigation is required to determine whether the effectexercise prescription is associated with prevention or evaluation on the stage of frailty syndrome. Additional research is needed to determine whether motivational factors may impact the learner’s prior cognitive and frail stage to process training program effectively. For example, the participant’s motivational states, attitudes about training program and self-esteem level may all play a part in their physical fitness or cognitive states to successfully interact with learning outcome.

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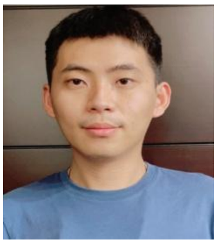

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