Received: 14 December 2023 | Revised: 22 January 2024 | Accepted: 23 January 2024
DOI: 10.48309/jmpcr.2024.435628.1090
Journal of Medicinal and Pharmaceutical Chemistry Research
SAMI

FULL PAPER

The effect of adding VIVIFRAIL© exercises to conventional exercises on quadriceps muscle strength and endurance in elderly people with frailty syndrome at surabaya nursing homes

Iriana Wahyu Nasifah[a] |Rwahita Satyawati[b,*] |Dyah Intania Sari[b] |Soenarnatalina Melaniani[c]

[a]Physical Medicine and Rehabilitation Residency Program, Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Airlangga University, Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, 60264

[b]Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Airlangga University, Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, 60264

[c]Department of Epidemiology, Biostatistics, Population Studies, and Health Promotion, Faculty of Public Health, Airlangga University, Surabaya, Indonesia, 60264

VIVIFRAIL© training can become an alternative comprehensive training program to treat Frailty Syndrome (SF) in Indonesia. Fourty elderly people with Frailty Syndrome (SF) subject this study. Subjects were divided into the intervention and control groups, each consisting of 20 elderly people. Both groups were required to participate in conventional exercises programmed by the Nursing Home 5-7x/week for ±15 minutes. The outcomes assessed were quadriceps muscle strength and endurance by measuring the digital dynamometer test (DD) and 30-second chair stand test (30CST) at baseline (pre-test) and after four weeks of intervention (post-test). The results showed significant differences in quadriceps muscle strength and endurance in the intervention group (right DD test p=0.001; left DD test p=0.001 and 30CST p=0.001). In the control group, there were also significant differences in quadriceps muscle strength and endurance (proper DD test p=0.016; left DD test p= 0.015 and 30CST p=0.003). Changes in quadriceps muscle strength in the right and left DD test between groups showed significant results between the pre-test and post-test between groups (p=0.044 and p=0.039). The delta effect size values of right and left quadriceps muscle strength are 0.626 and 0.612. Changes in quadriceps muscle endurance at 30CST between groups showed significant results in the pre-test and post-test between groups (p=0.017). The 30CST delta effect size value is 1.653. Adding multicomponent VIVIFRAIL© training for four weeks in elderly people with Frailty Syndrome can increase quadricep muscle strength, measured by the digital dynamometer test, and quadricep muscle endurance, measured by 30CST.

***Corresponding Author:**
Rwahita Satyawati
Email: rwahitas@yahoo.com
Tel.: +62 813-3016-1684

KEYWORDS
Frailty, multicomponent exercise, VIVIFRAIL©, quadriceps muscle strength, quadriceps muscle endurance, digital dynamometer test, 30CST .

Introduction

The escalating incidence of viral diseases, Population aging has become a global phenomenon. Almost every country in the world is experiencing a very drastic increase in the elderly population, both in number and proportion. Globally, there were 727 million people aged 65 or older in 2020 [1]. In elderly people around the world, the prevalence of Frailty Syndrome (SF) is 4-16% over 65 years and 25% in elderly aged 85 years [6]. Research at several health centres in Indonesia, cross-sectional data on 448 subjects aged > 60 years showed that the prevalence of Frailty Syndrome (SF) in elderly Indonesians in outpatient clinics was 25.2% in several health centres, with 27.2% accompanied by a prediction of a worsening condition, in 1 year [2]. In research conducted at the Surabaya elderly community on elderly people with an average age of 63 (60 – 100) years, the results showed that the prevalence of frailty was relatively high, namely 36.7% (men 5.2%, women 31.5%) [3].

Frailty is a syndrome in geriatrics characterized by reduced functional ability and adaptive function resulting from degradation of the process of various systems in the body, as well as increased vulnerability to multiple types of pressure (stressors) ult, ultimately reducing a person's functional performance. Based on clinical observations, frail elderly often have low body mass, poor muscle strength, balance and walking routine, and low physical activity [4]. Biological ageing is associated with a decline in the neuromuscular and cardiovascular systems, resulting in an impaired capacity to perform daily activities. In addition, age-related decline in muscle strength is also a significant predictor of functional limitations in healthy elderly, as well as in frail elderly [5].

Frailty causes complex problems and decreases independent living skills, resulting in the inability to prepare meals or carry out activities. Insufficient protein reduces muscle mass, while low calorie intake for daily needs causes malnutrition. This condition further exacerbates weight loss and cognitive impairment, increasing the need for assistance with activities of daily living such as dressing, eating, toileting, and locomotion. Outcomes of frailty include falls, injuries, hospitalizations, and comorbidities. Additionally, frailty is a predictor of poor prognosis in terms of disability, hospitalization, institutional residence, and death [6].

The quality of life of the elderly is decreasing, so health care is increasing. The severity of frailty was positively related to upper and lower limb muscle strength and endurance, static balance, cardiovascular endurance, upper and lower limb flexibility, dynamic balance and agility, and participation in physical activity [7]. A previous study on the elderly (age > 60 years old) which aimed to analyze muscle strength and physical performance stated that there was a positive association between muscle strength and physical performance, in the elderly community in Surabaya, Indonesia [9].

Lower extremity muscle strength was measured with a low-cost digital dynamometer introduced by Romero-Franco et al., 2017. Research conducted by Romero-Franco using the cost-effective 50 g precision digital dynamometer Carp Spirit Water Queen® (France) allows the evaluation of isometric strength in all sports contexts because it is portable, easy to use and cost-effective. The main findings of this study indicate that the digital dynamometer shows excellent validity and excellent inter-tester and intra-tester reliability for measuring maximal isometric strength in major lower extremity movements [10].

In research conducted by Cho et al., 2012 on 86 elderly people aged over 65 years, it was shown that the results of measuring lower limb strength using the 30-second Chair stand test (30CST) could conclude that poor lower limb strength was related to high risk of falling. Measuring 30CST is simple, without special equipment and skills [11]. In another study conducted by Justine et al., 2011 on elderly people aged 70 years who assessed the effect of multicomponent training on improving the physical function of elderly people for 12 weeks, one of which also measured the muscle endurance of the lower limbs, especially the quadriceps, with a 30s CST assessment which provided significant results [12].

Exercise is an effective method to delay or even reverse the progression of frailty and improve frailty components. A critical indicator of weakness is decreased muscle strength and endurance. A decrease in muscle strength occurs due to a reduction in muscle quality. At the same time, elderly people experience dysfunction and various diseases as part of the ageing process, often accompanied by inflammation. Inflammatory cytokines increase skeletal muscle catabolism, inhibit muscle protein synthesis, reduce lean muscle mass and muscle strength, and cause decreased activity or disability [13].

A multicomponent exercise program can provide significant results in improving the level of physical fitness in seniors over 65 years, where this multicomponent exercise includes balance, strength and stretching exercises carried out for four weeks [14]. Multicomponent exercise consisting of lower limb muscle strengthening exercise and balance exercise is very beneficial for the elderly. A study result states that this multicomponent exercise can increase walking speed and balance so that it can improve the physical performance of the elderly [15].

The primary effective interventions in preventing and even reversing frailty are physical exercise, multidimensional geriatric assessment and intervention in major geriatric syndromes, and emphasis on appropriate treatment adjustments. Positive effects of exercise interventions on functional capacity, fall rate, walking ability, balance, cardiorespiratory and strength performance may be observed more frequently when multiple physical conditioning components (i.e., strength, endurance, or balance) are included in the exercise intervention compared with only one type of exercise. Multicomponent exercise programs, especially those that have strengthening exercise, are the most effective interventions for delaying disability and other side effects [16].

One of the multicomponent exercises that includes muscle strengthening, balance, flexibility and cardiorespiratory endurance is VIVIFRAIL©. The VIVIFRAIL© program is an exercise on Frailty Syndrome developed in Europe (European Union's Erasmus program). The VIVIFRAIL© multicomponent exercise intervention program consists of resistance training, gait retraining and balance training, which is one of the best strategies to improve gait, balance and strength, as well as reduce the risk of falls in older individuals and maintain functional capacity throughout the lifespan [17]. In research conducted on 14 elderly people aged over 80 years in nursing homes for four weeks, the multicomponent exercise intervention VIVIFRAIL© significantly increased functional capacity and mobility [18].

Recent research on the VIVIFRAIL© exercise program in elderly people in nursing homes shows that VIVIFRAIL© exercise provides short-term and long-term protective benefits after periods of inactivity in the elderly. After short period (4 weeks) and long period (24 weeks), VIVIFRAIL© exercise programs in the elderly resulted in the elderly being in better condition than baseline after 6-14 weeks of inactivity. However, six weeks of inactivity caused a reduction in functional capacity even after 24 weeks of sports training; this shows how great the benefits of a regular exercise routine are for the elderly. Another important thing is that the condition of frailty was reversible in 36% of participants, with an achievement of 59% were able to achieve a high level of independence after 24 weeks of supervised exercise intervention, and elderly people who reached the robust level were able to maintain complete independence even after a period of detraining. This can answer global challenges related to maintaining functional capacity and reversing the condition of frailty in vulnerable elderly populations, so this exercise is very appropriate to consider using for elderly people who live in nursing homes with various activities that are prone to illness or falls which ultimately make them susceptible to atrophy. Muscles and the emergence of various musculoskeletal and metabolic diseases [19].

There is still little research objectively measuring the effect of multicomponent VIBIFRAIL training on quadriceps muscle strength and endurance. A decrease in quadriceps muscle strength and endurance will affect ambulation function, decreased walking speed, decreased activity level, and fatigue quickly, resulting in decreased functional capacity and quality of life for the elderly. Currently, various types of physical exercise are carried out in elderly groups and nursing homes. Conventional physical activity carried out by the elderly, especially in Surabaya, does not yet refer to standard, evidence-based recommended practice. Therefore, the authors are interested in further researching the effect of adding multicomponent VIBIFRAIL training to conventional training on quadriceps muscle strength and endurance in subjects with Frailty Syndrome.

Subjects

Ethical review approval was provided by the Ethical Committee of Soetomo General Academic Hospital Surabaya with number 11/EC/KEPK/2023. Participants were residents of Jambangan Nursing Home, Surabaya, and a Government-Funded Nursing Home.

This trial was not blinded for participants and investigators because the intervention could not be blinded. The proportional sampling method was used in this study. The sample size was determined using the Lemeshow formula, which resulted in at least 16 participants in each group. The sample size was increased by 20% to anticipate participant dropout during follow-up, bringing the total sample size to 40.

Inclusion criteria: 1) Elderly aged 60 years or more who live in an Jambangan nursing home; 2) Having at least one of five frailty phenotypes [6]; 3) being able to ambulate independently with or without assistive device with a Barthel Index >=60; 4)Good vision and hearing function; 5) There is no decline in cognitive function so that subjects can understand and follow instructions well (MoCa-Ina score≥26); 6)Stable hemodynamics; 7) Subjects are willing to take part in the research program by filling out an informed consent form.

Exclusion criteria included having factors that impeded the performance of the physical exercise program and testing procedures as prescribed by the physician. These factors refer to the VIBIFRAIL program implementation guidelines Izquierdo *et al.*, 2017 [17]:

1) Suffering from cardiorespiratory disease that affects physical performance during exercise (NYHA class 3-4 heart failure, COPD, acute heart attack, unstable angina, uncontrolled arrhythmia, aneurysm, severe aortic stenosis, acute endocarditis/pericarditis, and acute or severe respiratory failure); 2) Blood pressure (>180/100mmHg); 3) Uncontrolled postural hypotension; 4) Acute thromboembolism; 5) Have a history of fracture in the last 3 months or more than 3 months but not union as proven by X-Ray; 6) Suffering from an infectious disease that can affect the general condition and implementation of training; 7) Have other conditions that cause moderate to severe functional limitations (Barthel index <60); 8) Suffering from muscle pain and lower limb joint pain with WBFS (Wong Baker Face Scale) ≥ 4and clinical signs of swelling, redness and warmth to the touch; 9) Chronic diseases that interfere with the mobility function of the elderly (ambulatory disorders due to stroke, uncontrolled diabetes and balance disorders due to intracranial and extracranial processes such as BPPV and other neurological disorders that can disrupt balance); 10) Have received special physical training using methods other

than the routine program at a nursing home in the last 3 months.

Drop Out Criteria: 1) Subject withdraws; 2) The subject is not present for two consecutive meetings; 3) Attendance is less than 90% of the total attendance attended; 4) The subject is sick, so he has to stop the exercise program; 5) Died.

Methods

This research used a true experimental method with a pre and post-test randomized control group design. The research subjects were 40 elderly people with Frailty Syndrome who met the inclusion criteria and did not meet the exclusion criteria. Subjects were divided into intervention and control groups, each consisting of 20 elderly people. Two subjects dropped out of the study. Participants in the intervention exercise group received VIBIFRAIL exercises five times weekly for four weeks. Participants in both groups must participate in conventional exercises programmed by the Nursing Home 5-7x/week for ±15 minutes. The outcomes assessed were quadriceps muscle strength by assessing the digital dynamometer test (DD test) and quadriceps muscle endurance by assessing the 30-second chair stand test (30CST)) at baseline (pre-test) and after four weeks of intervention (post-test).

Statistical analysis

The data obtained will be input and processed using the SPSS 20.0 for Windows™ program. A descriptive data presentation was carried out to determine the characteristics of all data. Test data normality using the Shapiro-Wilk test. A parametric statistical test is carried out if the data is normally distributed. To test the comparison between before and after treatment in each group, use the paired sample t-test if the data is normally distributed; if the data is not normally distributed, then use the Wilcoxon rank sign test. Then, to compare the difference between the treatment and control groups, use the unpaired t-test if the data is normally distributed; if the data is not normally distributed, use the Mann-Whitney test.

Results

The characteristics, normality, and homogeneity data of the research subjects in both the intervention and control groups are presented in Table 1. The results of the paired sample t-test for quadriceps muscle strength in the intervention group are shown in Table 2. The results of the paired sample t-test for the control group's quadriceps muscle strength in Table 3 show that during the pre-test, the control group had an average right quadriceps muscle strength. A comparison of changes in right and left quadriceps muscle strength before and after training between the intervention and control groups is presented in Table 4. The results of the paired sample T-test 30CST for the intervention group are presented in Table 5.

The Paired T-Test 30CST of the control group is presented in Table 6. Comparison of Changes in the 30 Second Chair Stand Test Before and After Exercise between the Intervention and Control Groups is presented in Table 7 .

TABLE 1 Characteristics of research subjects

Characteristics	Intervention Group (n=20) Mean± SD (%)	Normality p value#	Control Group (n=20) Mean±SD (%)	Normality p value#
Age (years)	73.10±10.50	0.128	72.25±9.57	0.150
Gender				
Man	7 (35%)		10 (50%)	
Woman	13 (65%)		10 (50%)	
Frailty Category				
Pre-frailty	18 (90%)		17 (85%)	
Man	6 (30%)		8 (40%)	
Woman	12 (60%)		9 (45%)	
Frailty	2 (10%)		3 (15%)	
Man	1 (5%)		2 (10%)	
Woman	1 (5%)		1 (5%)	
FES-I category				
Low	7 (35%)		9 (45%)	
Man	5 (25%)		5 (25%)	
Woman	2 (10%)		4 (20%)	
Currently	10 (50%)		8 (40%)	
Man	1 (5%)		5 (25%)	
Woman	9 (45%)		3 (15%)	
Tall	3 (15%)		3 (15%)	
Man	1 (5%)		0 (0%)	
Woman	2 (10%)		3 (15%)	
Body weight (kg)	50.67±12.96	0.516	51.74±11.25	0.195
Height (m)	1.50±0.89	0.250	1.51±0.08	0.922
BMI (kg/m2)	22.33±5.04	0.448	22.91±5.38	0.079
SPPB value	9.60±1.57	0.103	8.60±1.60	0.165
Road speed 6m (m/sec)	0.79±0.19	0.548	0.73±0.18	0.580
Hand dominance				
Right	20 (100%)		20 (100%)	
Left	0 (0%)		0 (0%)	

#Data normality test with Shapiro Wilk, $p<0.05$;

Information: BMI= Body Mass Index; FES-I: Indonesian version of the Fall Efficacy Scale; SPPB= Short Physical Performance Battery.

TABLE 2 Results of paired sample T-Test quadriceps muscle strength intervention group

Variable	Group	Min (Nm)	Max (Nm)	Mean±SD (Nm)	Difference	Cohens'd	p
Right Quadriceps Strength	Pre-Test	19.65	68.73	38.83 ± 14.57	-25.50	1,314 (Very large)	<0.001*
	Post-Test	27.37	113.17	64.33 ± 23.25			
Left Quadriceps Strength	Pre-Test	19.68	82.52	42.53 ±16.95	-26.37	1,106	0.001*
	Post-Test	22,20	150.96	68.90 ± 29.14		(Very Large)	

*$p<0.05$ (Significantly different with a significance level of 5%)

TABLE 3 Paired sample T-Test results of control group quadriceps muscle strength

Variable	Group	Min (Nm)	Max (Nm)	Mean±SD (Nm)	Difference	Cohens'd	p
Right Quadriceps Strength	Pre-Test	19.37	52.39	34.37+13.34	-11.75	0.668 (Moderate)	0.016*
	Post-Test	19.78	98.51	46.13+21.01			
Left Quadriceps Strength	Pre-Test	18.67	65.56	34.41±15.05	-10.03	0.587	0.015*
	Post-Test	17.68	73.81	44.47± 8.94		(Moderate)	

*p<0.05 (Significantly different with a significance level of 5%)

TABLE 4 Results of independent sample t-test delta quadriceps muscle strength

Variable	Group	Min	Max	Mean± SD	p	Effect Size
Δ Right Quadriceps Muscle Strength	Intervention	1.07	65.58	25.50±21.78	0.044	0.626 (Moderate)
	Control	-20.90	66.91	11.75±19.85		
Δ Left Quadriceps Muscle Strength	Intervention	0.07	115.61	26.37±29.67	0.039	0.612 (Moderate)
	Control	-4.83	54.97	10.05±16.85		

*p<0.05 (Significantly different with a significance level of 5%)

TABLE 5 Paired sample T-Test results in 30CST intervention group

Variable	Group	Min	Max	Mean± SD	Difference	Cohens'd	p
30CST	Pre-Test	9.00	15.00	11.90 ± 1.74	-2.7	1,456 (Very Large)	<0.001*
	Post-Test	11.00	20.00	14.60 ± 1.95			

*p<0.05 (Significantly different with a significance level of 5%)

TABLE 6 Results of paired T-Test 30CST control group

Variable	Group	Min	Max	Mean± SD	Difference	Effect Size	p
30CST	Pre-Test	6.00	14.00	10.00 + 2.77	-1.4	0.542 (Moderate)	0.003*
	Post-Test	6.00	15.00	11.40 + 2.37			

*p<0.05 (Significantly different with a significance level of 5%)

TABLE 7 Independent sample T-Test 30CST test results

Variable	Group	Min	Max	Mean± SD	Difference	Cohens'd	p
Δ30CST	Intervention	1.00	6.00	2.70±1.42	1.32	1,653 (Very Large)	0.017*
	Control	-2.00	4.00	1.40±1.85			

*p<0.05 (Significantly different with a significance level of 5%)

Discussion

In this study, the characteristics of age above 70 years were in the intervention and control groups. Increasing age will increase the prevalence of frailty. In the research characteristics data, elderly people with pre-frailty are in the age range of 60-80 years, while in the frailty category in the intervention and control groups, there are four people over 85 years old and one person aged 75 years. Bean et al., 2020 stated that ageing is associated with decreased strength, muscle endurance, and limited mobility in elderly people related to increased prevalence factors of frailty [6].

Characteristics of participants with pre-frailty numbers with an age range of 60-80 years in the intervention and control groups: there were more women than men. However, in the data, the number of participants in the intervention group was more women than men, while in the control group, the number of participants was men and women were the same size. In the frailty category, those aged over 85 in the intervention group were the same for men and women, while in the control group, the number was greater for men. This characteristic data is in line with the results of other studies, which state that in the age range 65-79 years, the prevalence of elderly women with pre-frailty is 61.8%, and men 58.3%. In contrast, the prevalence of elderly women with frailty is 6.4% and men men 4.2%. At the age of 80-89 years, the prevalence of elderly women with pre-frailty is 60.3%, men are 63.8%, while the prevalence of elderly women with frailty is 24.2%, and men are 14.8%. At the age of 90-99 years, the prevalence of elderly women with pre-frailty is 46.5%, men are 52.5%, elderly women with frailty is 45.4%, and men are 32.4%. In this study, a specific analysis based on gender showed that weight loss, weakness and low walking speed were more common in women in all age groups, while inactivity was more common in men [20].

Women dominated the fear of falling category (FES-1) compared to men in the intervention and control groups. This is in line with previous research, which shows that the level of fear of falling in women is higher than in men in various countries such as the Netherlands, Australia, Turkey, China and Iran. This fear of falling is related to various factors, both intrinsic and extrinsic. Intrinsic factors include decreased muscle strength, flexibility, impaired balance, vertigo and difficulty walking. Extrinsic factors relate to the surrounding environment, such as slippery roads, uneven roads, potholes, etc. The intensity of the risk of falling is related to frailty, decreased daily activities and a history of previous falls [21].

Assessment of the functional capacity of the elderly is measured using the Short Physical Performance Battery (SPPB) score. Lower limb muscle strength and endurance conditions influence low SPPB values and slower walking speed [18]. In this study, the average baseline data of 6m walking speed in the intervention and control groups was not significantly different ($p>0.05$). Likewise, the SPPB values in both groups at the time of screening were normally distributed ($p>0.05$).

The results of this study showed that the addition of multicomponent VIBIFRAIL exercise—to conventional exercise for four weeks increased right and left quadriceps muscle strength in elderly people who were examined using the digital dynamometer test ($p<0.001$ and $p=0.001$). The four weeks of multicomponent VIBIFRAIL exercise significantly increased the quadriceps muscle strength of both legs compared to the control group, which had a moderate effect. Even though the examination results of the research subject's hand dominance were right, reflecting the dominance of the right leg, the examination results of right and left quadriceps muscle strength were balanced both pre and post-intervention in the intervention and control groups.

The addition of VIBIFRAIL exercises to the intervention group was divided into 3 exercise groups, namely categories C, C+E and D. Of the 20 subjects in this study, two people were in category C (10%), category C+E, seven people (35%) and category D as many as 11 people (55%). The VIBIFRAIL multicomponent exercise prescription refers to the exercise protocol developed by Izquierdo et al. in 2017 [17].

VIBIFRAIL exercise has flexibility, balance and cardiovascular exercise components. VIBIFRAIL is the dominant component, which is programmed five times per week while strengthening exercise is programmed three times per week with a total duration of 30-60 minutes. Exercise intensity and load increases are evaluated and carried out every two weeks. Strengthening exercises for the upper and lower limbs can increase blood circulation and skeletal muscle metabolism. This influence contributes to the remodeling process, leading to changes in muscle mass and volume. An increase in muscle oxidative capacity due to stimulation of mitochondrial biogenesis is an effect of resistance training. Balance exercise will optimize the ability to function with sensory input and cognitive and musculoskeletal control. Flexibility exercises will maintain the joint range of motion [22]. All components of this exercise will improve muscle strength, which decreases in elderly people with Frailty Syndrome [23].

In line with this, VIBIFRAIL's multicomponent exercise provides greater benefits when compared to conventional exercise, which only consists of low-intensity aerobic exercise and stretching exercises with a duration of 10-15 minutes daily.

The results of this study align with the findings of a systematic review analyzing 13 studies. Regarding the effects of physical exercise interventions on lower body muscle strength in elderly people with Frailty Syndrome. Nine studies found an increase in muscle strength after a period of physical exercise, while four studies did not identify any increase. Five studies showing strength gains used resistance training programs, and four used multicomponent exercise interventions. Average strength increases range from 6 to 60% [5].

The results of another study with elderly participants with an average age of 67 years were 37 participants who were divided into two groups, namely the multicomponent exercise group and the lower limb strength training group for 12 weeks three times per week. The results of both exercises showed increased knee extensor muscle strength with a value of $p = 0.002$. However, the results of knee extensor muscle strength in the lower leg strengthening exercise group were greater than those in the multicomponent exercise group, this was due to the large stimulation of strengthening exercise resulting in adaptive changes in neuronal motor function, namely firing frequency and motor unit recruitment. This research also states that lower limb strengthening exercise can improve muscle function and dynamic balance, while multicomponent training can increase functional capacity and walking ability. It is suspected that multicomponent exercise is effective in increasing the functional capacity of the elderly because physical exercise movements imitate daily life activities (e.g. walking and squatting). In addition, there is evidence that multicomponent exercises effectively increase ankle muscle strength associated with walking ability [14]. This is similar to the results obtained with the addition of VIBIFRAIL training in this study, which provided increased quadricep muscle strength and better physical performance.

The control group in the study also obtained significantly different results from conventional training (aerobic and stretching exercise) with changes in increasing quadriceps muscle strength with a moderate effect. In line with this research, namely low-impact aerobic exercise on 24 elderly people aged 60-70 years in 16 training sessions with a training frequency of 3 times per week, moderate intensity, for 30 minutes, the results showed that apart from providing significant improvements in body fitness, there was also an increase in strength. Lower limb muscles (p=0.003) [24]. Other research states that it is currently recommended that healthy seniors should exercise 3 or 4 times a week to get the best results; people with poor physical performance can initially achieve muscle strength gains even with less frequent and shorter training periods [25].

In this study, it was found that the magnitude of the change in the right and left digital dynamometer tests in the intervention group and the control group was found to be a significant difference in the delta effect size value of right and left knee extensor muscle strength after intervention between groups in this study, indicating a moderate effect. These results indicate that adding VIBIFRAIL training for four weeks in elderly people with Frailty Syndrome can increase quadriceps muscle strength better than exercise.

Loss of muscle strength in the elderly is closely related to fragility and loss of lean body mass. Previous research has linked muscle weakness to impaired nerve activation and/or reduced intrinsic strength capacity of skeletal muscles [26–28]. It was found that resistance training is a potent stimulus for skeletal muscle metabolism in the elderly, especially for the contractile unit, due to the increased rate of fractional synthesis of myofibrillar proteins in skeletal muscle [29]. In the VIBIFRAIL exercise, resistance training is provided using rubber weights and ankle weights, which are adapted to the abilities of the elderly. This is a training modality that is quite effective in increasing muscle strength. Previous research suggests that a strengthening exercise intervention performed three times a week, with three sets of 8 to 12 repetitions and an intensity ranging from 20–30% and continuing up to 80% of 1RM, can be tolerated by subjects with Frailty Syndrome (SF), resulting in increased strength real muscle [5]. This recommendation was gradually implemented during the VIBIFRAIL exercise program in the intervention group.

In line with the results of this study, Gonzales-Rave et al., 2020 reported the results of their research on changes in multicomponent exercise on increasing lower limb muscle strength for ten weeks in 48 elderly women with an average age of 65.7 years. The multicomponent training provided consists of strengthening exercises (1 time per week, 60-70%1RM. 12-15 repetitions, three sets), aerobic exercise (1 time per week, 60-70% estimated heart rate, for 40 minutes), flexibility exercise (2 times per week, 1-3 sets, ten repetitions), balance exercise (1 time per week, progress with various levels of difficulty), and coordination and agility exercise -(1 time per week, advancement with various levels of difficulty). The results showed a significant change in the increase in lower limb strength with p<0.005 [30]. Even though there are differences in frequency, intensity and duration of exercise, they have the same exercise components. They provide similar results in increasing lower limb muscle strength with the multicomponent VIBIFRAIL exercise in this study.

In another study with participants aged over 65 years, a multicomponent exercise intervention was carried out for 24 weeks, one time per week. This multicomponent exercise includes strength, balance, and flexibility. Multicomponent exercise significantly improves ROM, muscle strength, and physical performance in healthy older adults. Knee extensor muscle strength resulted in a significant increase in power of 14.1% (p=0.008). The results of this study prove that exercise without using special equipment, namely multicomponent training, can provide good results in increasing knee extensor muscle strength in the elderly. Apart from that, it also increases mobility and functional independence in healthy elderly people [31].

In the control group, changes in muscle strength were also found, but not as high as in the intervention group. The average delta quadriceps muscle strength before and after training increased; the increase in right quadriceps strength was 14.47±21.77 Nm, and the left was 14.17±18.65. These findings are similar to those reported in other previous studies. In the study by Kim et al., 2012, the participants were elderly Japanese and received training on walking patterns, balance, and lower limb strength two times a week. Leg strengthening exercises include applying weights with weight cuffs on the ankles weighing 0.50 to 1.50 kg and resistance bands [32]. These results may be due to the amount of load applied and the frequency of training not providing sufficient stimulation to facilitate strength gains [5,33].

In this study, it was found that the magnitude of the change in 30CST values before and after intervention in the intervention group was found to be a significant difference of $p<0.001$. The effect size value of the 30CST test in the intervention group showed a very large effect from adding VIBIFRAIL and conventional exercise in the intervention group for four weeks. In the control group, there was a significant difference between the mean 30CST before and after treatment with moderate effect size values in conventional training for four weeks. These results show that adding VIBIFRAIL exercise has a very large effect compared to conventional training alone. Even though the results of the examination of the hand dominance of the research subjects were right, which also reflects the dominance of the right leg, the results of the examination of the endurance of the right and left quadriceps muscles were quite balanced both pre-and post-intervention in the intervention and control groups.

The latest systematic study also states that increasing local muscle endurance in the elderly is closely related to increasing muscle strength; this shows that strengthening exercise interventions that target muscle strength can be the most effective strategy for overcoming muscle endurance problems in the elderly, of which strengthening exercise is one component of a multicomponent exercise. Potential mechanisms contributing to local increases in muscle endurance that may also be related to muscle strength are increases in oxidative capacity, capillarization and mitochondrial density, and metabolic enzyme activity [20]. This supports this study's results that VIBIFRAIL training consists of strengthening, cardiovascular, flexibility and balance exercises and provides better results than conventional exercise, which consists of aerobic and stretching exercises only.

The results of another study conducted by Wolf et al., 2020 with 37 elderly women aged 67 years as participants [14]. This study compares the effects of multicomponent and lower limb strengthening exercise on dynamic balance, functional capacity and walking ability. Exercises were carried out for 12 weeks, three times per week. One of the functional examinations measured is 30CST. The results were that both exercises gave significant results with a p-value = 0.010 and a higher effect size value in the multicomponent exercise group (d = -0.54). Multicomponent exercises provides more specificity of training mechanics compared to strengthening exercises alone. Multicomponent exercise is more suitable for increasing functional capacity than strengthening exercises alone because of its association with independence in daily life activities in the elderly [14]. The results of this study support this research, which shows that multicomponent exercises, including VIBIFRAIL exercises, can increase the strength and endurance of the quadriceps muscles and can also help increase the independence of elderly people in daily activities.

This study found that the magnitude of change in 30CST in the intervention group and the control group was significantly different, with delta 30CST p=0.019. The delta 30CST effect size value in this study was 1.653, indicating a very large effect from the addition of VIBIFRAIL and conventional exercise in the intervention group.

Research by Justine et al., 2012 provided similar results regarding increased lower leg muscle endurance after multicomponent exercise [12]. The research aimed to measure the effect of multicomponent exercise (aerobic, endurance, balance and flexibility training) for 12 weeks, three times a week, on physical function in elderly people treated in institutions. Forty-three participants (age = 70.88 ± 7.82 years) were divided into intervention (n = 23) and control (n = 20) groups. The results obtained were a significant increase in lower limb endurance (30 CST) ($p<0.05$) in the intervention group, with a percentage change of 46.9%. The control group showed no significant changes ($p>0.05$) in any variable. The strengthening exercise protocol given is based on the functional tasks required for daily activities: half-squatting, sitting to standing and continuing with holding objects. Functional test to determine the endurance of the knee extensor muscles using 30CST. Data show that multicomponent exercise for 12 weeks can improve physical function in elderly people treated in institutions [12]. The results of Justine et al.'s 2012 research support the results of this study that multicomponent training not only improves knee extensor muscle endurance but also improves the physical function of the elderly.

The control group's results with conventional exercise also showed significant changes in quadriceps muscle endurance. Still, when compared with multicomponent exercise, the changes were greater. The results of the control group are in line with research by Hou and Sun, 2022 which stated that aerobic exercise (walking exercise on a treadmill) three times per week for 12 weeks in the elderly, with the initial three weeks lasting 20 minutes, then gradually increasing the duration and intensity, the results obtained changed lower limb muscle strength and endurance were significantly different ($p<0.005$). Aerobic exercise effectively improves the lower limbs' cardiorespiratory function, strength and endurance. However, the increase in muscle mass is still minimal. Physical exercise can maintain muscle strength and endurance as well as improve muscle and nerve function in the elderly, so one option is aerobic exercise, which is simple and easy to regulate in intensity, which includes walking, cycling, climbing and others [34].

In this study, additional multicomponent VIBIFRAIL training was given for four weeks to elderly people with Frailty Syndrome at the Jambangan nursing home, Surabaya. Quadriceps muscle strength was assessed using digital dynamometer measurements before and after VIBIFRAIL exercise; results showed significant differences when compared with the control group. Apart from that, the large impact size supports the superiority of this exercise in increasing functional capacity and independence in elderly people with Frailty Syndrome in a fairly short period of 4 weeks.

In addition, quadriceps muscle endurance assessed with 30CST before and after in both intervention and control groups provided a significant difference. Still, the effect size value in the intervention group provided a greater effect. This is a strong basis that supports the implementation of the use of VIBIFRAIL in elderly people with Frailty Syndrome, who generally often complain of problems with lack of muscle endurance, functional capacity and ability to walk. It is hoped that by increasing quadriceps muscle endurance, elderly people will become more active, fit, and independent.

The provision of the VIBIFRAIL exercise program to the elderly is adjusted to their respective functional levels by carrying out rapid screening according to the VIBIFRAIL exercise protocol with SPPB and fear of falling. Before the intervention begins, the elderly receive a program introduction session. During the exercise intervention, the elderly receive supervision and assistance to train optimally and increase their motivation and compliance during exercise.

During the implementation of this exercise, no side effects were found in the elderly both during and after exercise. This condition supports that VIBIFRAIL training is safe for elderly people with pre-frailty and frailty. The research results and observations of researchers during carrying out this research support that the multicomponent VIBIFRAIL exercise is so beneficial that it is recommended as a routine exercise to be given to elderly subjects with Frailty Syndrome in nursing homes to increase the strength and endurance of the quadriceps muscles. With these findings, it is hoped that further research can be carried out in wider communities and clinical settings.

Limitations in this research include: 1) No objective monitoring was carried out during the research with VIBIFRAIL exercise to monitor the achievement of exercise intensity; 2) No monitoring of activities outside of treatment was carried out; 3) The control group was still given conventional exercises that are routinely given in nursing homes so that the comparison between the intervention group and the control group could not be compared.

Conclusion

The addition of multicomponent VIBIFRAIL exercise for four weeks in elderly people with Frailty Syndrome can increase quadricep muscle strength, as measured by the digital dynamometer test, and quadricep muscle endurance, as measured by 30CST.

Acknowledgements

None.

Funding

None.

Authors' Contributions

All authors contributed in this study.

Conflict of Interest

None.

Orcid:

Iriana Wahyu Nasifah:
https://orcid.org/0009-0007-4282-5229
Rwahita Satyawati:*
https://orcid.org/0000-0001-9600-0731
Dyah Intania Sari:
https://orcid.org/0009-0005-9189-3506
Soenarnatalina Melaniani:
https://orcid.org/0000-0002-4449-153X

References

[1] APL. Girsang, KD. Ramadani, SW. Nugroho, NP. Sulistyowati, Statistik penduduk lanjut Usia, subdirektorat statistik pendidikan dan kesejaahteraan sosial, *Badan Pusat Statistik: Jakarta*, **2021**, *1*, 1–34. [Google Scholar], [Publisher]

[2] S. Setiati, P.W. Laksmi, I.S. Aryana, S. Sunarti, N. Widajanti, L. Dwipa, E. Seto, R. Istanti, L.J. Ardian, S.C. Chotimah, Frailty state among Indonesian elderly: prevalence, associated factors, and frailty state transition, *BMC geriatrics*, **2019**, *19*, 1-10. [Crossref], [Google Scholar], [Publisher]

[3] N. Widajanti, J. Ichwani, R.S. Dharmanta, H. Firdausi, Y. Haryono, E. Yulianti, K. Husna, Sarcopenia and frailty profile in the elderly community of Surabaya: a descriptive study, *Acta medica Indonesiana*, **2020**, *52*, 5-13. [Google Scholar], [Publisher]

[4] a) D. Siallagan, J. Gessal, Geriatric frailty syndrome, *Jurnal medik dan rehabilitasi*, **2021**, *3*. [Google Scholar], [Publisher], b) A.M. Aghdam, F. Rousta, Prevalence of Hypocalcemia Following Thyroidectomy, *Eurasian Journal of Chemical, Medicinal and Petroleum Research*, **2023**, *2*, 12-23. [Crossref], [Google Scholar], [Publisher], c) A.H. Hattab, S. Beebany, A.S. Kaki, The effect of H_2SO_4 concentration on corrosion of Kirkuk's oil and gas pipelines with studying corrosion

reaction rates kinetically, *Chemical Methodologies*, **2023**, *7*, 257-267. [Crossref], [Google Scholar], [Publisher], d) B. Naghipour, V. Rahmani, Efficacy of intravenous acetaminophen during the first 24 hours after caesarean section: a systematic review, *International Journal of Advanced Biological and Biomedical Research*, **2023** *11*, 104-114. [Crossref], [Pdf], [Publisher], e) A.R. Lotfi, H.O. Osquee, Investigating factors affecting hospitalization of patients with mucormycosis after contracting COVID-19: a systematic review, *International Journal of Advanced Biological and Biomedical Research*, **2023**, 35-47. [Crossref], [Google Scholar], [Publisher]

[5] a) E.L. Cadore, A. Casas-Herrero, F. Zambom-Ferraresi, F. Idoate, N. Millor, M. Gómez, L. Rodriguez-Mañas, M. Izquierdo, Multicomponent exercises including muscle power training enhance muscle mass, power output, and functional outcomes in institutionalized frail nonagenarians, *Age*, **2014**, *36*, 773-785. [Crossref], [Google Scholar], [Publisher], b) M.S. Sanie Jahromi, R. Sahraeai, S. Shafa, M. Ghaedi, M. Ranjbar, H. Zabetian, Comparison of effects of oral melatonin and gabapentin on pain and hemodynamic symptoms in patients undergoing upper limb orthopedic surgery, *Eurasian Journal of Science and Technology*, **2023**, *3*, 160-168. [Crossref], [Google Scholar], [Publisher], c) M. Jafari, Review of proposed strategies to improve nutrition in different communities, *Progress in Chemical and Biochemical Research*, **2022**, *5*, 77-96. doi: [Crossref], [Pdf], [Publisher], d) F. Mohamadpour, Acridine yellow G as a photo-induced electron transfer catalyzed radical metal-free synthesis of tetrahydrobenzo [b] pyran scaffolds in an aqueous media, *Current Research in Green and Sustainable Chemistry*, **2023**, *6*, 100356. [Crossref], [Google Scholar], [Publisher], e) A. Mehdinavaz Aghdam, F. Rousta, Determination of risk factors for cholelithiasis in patients with morbid obesity, *Eurasian Journal of Science and Technology*, **2023**, *3*, 104-108. [Crossref], [Pdf], [Publisher], f) P.A. Kalvanagh, Y.A. Kalvanagh, Designing the cognitive model of survivors after mastectomy, *International Journal of Advanced Biological and Biomedical Research*, **2023**, *11*, 72-81. [Crossref], [Pdf], [Publisher]

[6] a) L.P. Fried, A.A. Cohen, Q.L. Xue, J. Walston, K. Bandeen-Roche, R. Varadhan, The physical frailty syndrome as a transition from homeostatic symphony to cacophony, *Nature aging*, **2021**, *1*, 36-46. [Crossref], [Google Scholar], [Publisher], b) S. Rozmina, A. Bagheri Moghadam, S.M. Sadrzadeh, V. Vakili, H. Zamani Moghaddam, M. Talebi Doluee, Comparison of the effects of ranitidine and pantoprazole on the incidence of ventilator-associated pneumonia, *Eurasian Journal of Science and Technology*, **2023**, *3*, 67-72. [Crossref], [Pdf], [Publisher], c) S.M.H. Hosseini, M.R. Naimi-Jamal, M. Hassani, Preparation and characterization of mebeverine hydrochloride niosomes as controlled release drug delivery system, *Chemical Methodologies*, **2022**, *6*, 591-603. [Crossref], [Pdf], [Publisher], d) B. Farhadi, M. Ebrahimi, A. Morsali, Pre-concentration and sensitive determination of propranolol and metoprolol using dispersive solid-phase microextraction and high-performance liquid chromatography in biological, wastewater, and pharmaceutical samples, *Chemical Methodologies*, **2022**, *6*, 750-761. [Crossref], [Pdf], [Publisher], e) P.E. Ojike, C.E. Orji, K.B. Okeoma, C.A. Madu, U. Rilwan, Establishment of diagnostic reference levels for adult head CT examinations in rivers state, South-South Nigeria, *International Journal of Advanced Biological and Biomedical Research*, **2024**, *12*, 1-10. [Crossref], [Pdf], [Publisher]

[7] A. Susanti, R.I.L. Wardhani, I.P.A. Pawana, The relationship between quadriceps muscle atrophy and proprioception function in knee osteoarthritis patients, *Surabaya Physical*

Medicine and Rehabilitation Journal, **2019**, *1*, 59. [Crossref], [Google Scholar], [Publisher]

[8] L.I. Pei-Shan, C.J. Hsieh, M.I.A.O. Nae-Fang, A study of physical activity, frailty, and health-related quality of life among community-dwelling older adults in Taiwan, *The Journal of Nursing Research*, **2020**, *28*, 124. [Crossref], [Google Scholar], [Publisher]

[9] T. Kristiana, N. Widajanti, R. Satyawati, Association between muscle mass and muscle strength with physical performance in elderly in Surabaya, *Surabaya Phys Med Rehabil J*, **2020**, *2*, 24. [Crossref], [Google Scholar], [Publisher]

[10] N. Romero-Franco, P. Jiménez-Reyes, J.A. Montaño-Munuera, Validity and reliability of a low-cost digital dynamometer for measuring isometric strength of lower limb, *Journal of Sports Sciences*, **2017**, *35*, 2179-2184. [Crossref], [Google Scholar], [Publisher]

[11] K.H. Cho, S.K. Bok, Y.J. Kim, S.L. Hwang, Effect of lower limb strength on falls and balance of the elderly, *Annals of rehabilitation medicine*, **2012**, *36*, 386-393. [Crossref], [Google Scholar], [Publisher]

[12] M. Justine, T.A. Hamid, V. Mohan, M. Jagannathan, Effects of multicomponent exercise training on physical functioning among institutionalized elderly, *International Scholarly Research Notices*, **2012**, *2012*. [Crossref], [Google Scholar], [Publisher]

[13] X. Lai, L. Bo, H. Zhu, B. Chen, Z. Wu, H. Du, X. Huo, Effects of lower limb resistance exercise on muscle strength, physical fitness, and metabolism in pre-frail elderly patients: a randomized controlled trial, *BMC geriatrics*, **2021**, *21*, 1-9. [Crossref], [Google Scholar], [Publisher]

[14] A. Wolf, D. Cowen, B. Paige, Human toxoplasmosis: occurrence in infants as an encephalomyelitis verification by transmission to animals, *Science*, **1939**, *89*, 226-227. [Crossref], [Google Scholar], [Publisher]

[15] M. Prayogo, R. Satyawati, D.I. Sari, D. Tinduh, S.M.M. Wulan, Y. Mikami, S. Melaniani, Locomotion training addition to regular aerobic exercise improves walking speed and two-step test of the institutionalized older adult with Locomotive Syndrome stage 1: a randomized controlled trial, *Bali Medical Journal*, **2023**, *12*, 771-775. [Google Scholar], [Publisher]

[16] L. Kartika, I. Subadi, I.P.A. Pawana, M. Andriana, P. Sugianto, Correlation of fatigue on walking ability in myasthenia gravis patients: a cross-sectional study, *Annals of Medicine and Surgery*, **2024**, *86*, 115-120. [Crossref], [Google Scholar], [Publisher]

[17] M. Izquierdo, L. Rodriguez-Mañas, A.J. Sinclair, VIBIFRAIL Investigators Group, What is new in exercise regimes for frail older people—How does the Erasmus VIBIFRAIL Project take us forward?, *The journal of nutrition, health & aging*, **2016**, *20*, 736-737. [Crossref], [Google Scholar], [Publisher]

[18] Á. Buendía-Romero, S. García-Conesa, J.G. Pallarés, J. Courel-Ibáñez, Effects of a 4-week multicomponent exercise program (VIBIFRAIL) on physical frailty and functional disability in older adults living in nursing homes, *Cuadernos de Psicología del Deporte*, **2020**, *20*, 74-81. [Crossref], [Google Scholar], [Publisher]

[19] J. Courel-Ibáñez, Á. Buendía-Romero, J.G. Pallarés, S. García-Conesa, A. Martínez-Cava, M. Izquierdo, Impact of tailored multicomponent exercise for preventing weakness and falls on nursing home residents' functional capacity, *Journal of the American Medical Directors Association*, **2022**, *23*, 98-104. [Crossref], [Google Scholar], [Publisher]

[20] H.Y. Wang, X. Lv, J. Du, G. Kong, L. Zhang, Age-and gender-specific prevalence of frailty and its outcomes in the Longevous population: the Chinese longitudinal healthy longevity study, *Frontiers in medicine*, **2021**, *8*, 719806. [Crossref], [Google Scholar], [Publisher]

[21] C.M.A. Marques-Vieira, L.M.M. Sousa, S. Severino, L. Sousa, S. Caldeira, Cross-cultural validation of the falls efficacy scale

international in elderly: systematic literature review, *Journal of Clinical Gerontology and Geriatrics*, **2016**, *7*, 72-76. [Crossref], [Google Scholar], [Publisher]

[22] I.L. Wardhani, I.K.G.A.B. Wirawan, I.P.A. Pawana, P. Maria, Conventional Low Intensity Pulsed-Ultrasound Therapy Increases Osteoblast, Serum Alkaline Phosphatase, and Serum Calcium Levels in Fracture Healing Process, *Cermin Dunia Kedokteran*, **2018**, *45*, 167-170. [Crossref], [Google Scholar], [Publisher]

[23] W.K. Mitchell, J. Williams, P. Atherton, M. Larvin, J. Lund, M. Narici, Sarcopenia, dynapenia, and the impact of advancing age on human skeletal muscle size and strength; a quantitative review, *Frontiers in Physiology*, **2012**, *3*, 260. [Crossref], [Google Scholar], [Publisher]

[24] C. Rismayanthi, M.I. Zein, R. Mulyawan, R. Nurfadhila, R.R. Prasetyawan, M.S. Antoni, The effect of low impact aerobic exercise on increasing physical fitness for the elderly. *Jurnal Keolahragaan*, **2022**, *10*, pp.137-146. [Crossref], [Google Scholar], [Publisher]

[25] F. Mayer, F. Scharhag-Rosenberger, A. Carlsohn, M. Cassel, S. Müller, J. Scharhag, The intensity and effects of strength training in the elderly, *Deutsches Ärzteblatt International*, **2011**, *108*, 359. [Crossref], [Google Scholar], [Publisher]

[26] A. Irawati, S.W. Mudjanarko, Tinduh, D., Effects of treadmill exercises on pancreatic β cell function through the role of vitamin D in patients with type 2 diabetes mellitus, *Gaceta Médica de Caracas*, **2021**, *129*, 357-366. [Crossref], [Google Scholar], [Publisher]

[27] S. Theodora, D. Tinduh, R.I.L. Wardhani, Does treadmill training improve balance function of healthy untrained young adult males, *Surabaya Physical Medicine and Rehabilitation Journal*, **2019**, *1*, 44. [Crossref], [Google Scholar], [Publisher]

[28] K.S. Jung, M.J. Hutchinson, C. Chotiyarnwong, M.K. Kusumawardani, S.H. Yoon, Y. Mikami, P. Laohasinnarong, D. Tinduh, P. Prachgosin, I. Narasinta, P. Chotiyarnwong, Dissonance in views between healthcare professionals and adults with a spinal cord injury with their understanding and interpretation of exercise intensity for exercise prescription, *BMJ Open Sport & Exercise Medicine*, **2023**, *9*, 1487. [Crossref], [Google Scholar], [Publisher]

[29] T. Seene, P. Kaasik, Muscle weakness in the elderly: role of sarcopenia, dynapenia, and possibilities for rehabilitation, *European Review of Aging and Physical Activity*, **2012**, *9*, 109-117. [Crossref], [Google Scholar], [Publisher]

[30] J.M. González-Ravé, R. Cuéllar-Cañadilla, T. García-Pastor, D. Juárez Santos-García, Strength improvements of different 10-week multicomponent exercise programs in elderly women, *Frontiers in Public Health*, **2020**, *8*, 130. [Crossref], [Google Scholar], [Publisher]

[31] H. Jung, Y. Miki, R. Tanaka, M. Yamasaki, The effects of a multicomponent lower extremity training technique on physical function in healthy older adults: A randomized controlled trial, *Gerontology and Geriatric Medicine*, **2020**, *6*, 2333721420935702. [Crossref], [Google Scholar], [Publisher]

[32] H.K. Kim, T. Suzuki, K., Saito, H., Yoshida, H. Kobayashi, H. Kato, M. Katayama, Effects of exercise and amino acid supplementation on body composition and physical function in community-dwelling elderly Japanese sarcopenic women: a randomized controlled trial, *Journal of the American Geriatrics Society*, **2012**, *60*, 16-23. [Crossref], [Google Scholar], [Publisher]

[33] F.N.A. Dzakiya, D. Tinduh, D.N. Utomo, Risk Estimation of Anterior Cruciate Ligament (ACL) Injury in East Java Puslatda Pencak Silat Athletes, *Surabaya Physical Medicine and Rehabilitation Journal*, **2021**, *3*, 29-38. [Crossref], [Google Scholar], [Publisher]

[34] N. Hou, X. Sun, Effect of aerobic exercise on neuromuscular quality in the elderly, *Revista Brasileira de Medicina do Esporte*, **2022**, *28*, 509-512. [Crossref], [Google Scholar], [Publisher]

How to cite this article: Iriana Wahyu Nasifah, Rwahita Satyawati*, Dyah Intania Sari, Soenarnatalina Melaniani, The effect of adding VIBIFRAIL© exercises to conventional exercises on quadriceps muscle strength and endurance in elderly people with frailty syndrome at surabaya nursing homes. *Journal of Medicinal and Pharmaceutical Chemistry Research*, 2024, 6(6), 739-755. **Link:** https://jmpcr.samipubco.com/article_189222.html