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Potential of Omega-3 Supplementation on Muscle Mass, Muscle Strength, and Physical Performance in Elderly Community

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Abstract

BACKGROUND: Geriatric problem characterized by reduced functional ability and impaired adaptation function caused by the decline in various body systems, as well as increased vulnerability to various kinds of stressors, which reduce a person's functional performance.

AIM: This study was aimed to explore the effect of omega-3 supplementation on muscle mass, muscle strength, and physical performance in the elderly community in Palembang, Indonesia.

METHODS: This study is an open clinical trial, to assess the potential of omega-3 supplementation on muscle mass, handgrip strength, and physical activity of elderly community. Omega-3 is given as much as 1.2 g once a day for 12 weeks orally. Muscle strength was assessed using Bioelectrical Impedance Analysis. Meanwhile, the muscle strength was assessed with a muscle dynamometer.

RESULTS: Omega-3 supplementation has only shown potent efficacy in improving muscle strength in geriatrics patients (before omega-3 supplementation 25.1 + 5.11; after omega-3 supplementation 26.2 + 5.16; $p < 0.05$). Omega 3 supplementation did not show significant improvement in muscle mass and gait ability in elderly patients.

CONCLUSIONS: Omega-3 supplementation improves handgrip strength but does not increase muscle mass and physical performance for geriatrics.

Introduction

The process of ageing is physiological, but the onset, rate of speed and the extent to which the progression of ageing at the level of cells, tissues, organs, and systems is very heterogeneous because it is influenced by genetic and environmental factors [1]. The ageing process can achieve successful ageing (there is no pathological condition and any defects), usual/normal ageing (there is a disease or decreased physiological reserve capacity which is often interpreted as a result of age), and pathologic ageing (there is a severe chronic disease or severe impairment that requires assistance/dependence on other people to carry out activities of daily living). Therefore, the ageing process is associated with an increased risk of vulnerability [1], [2]. Frailty syndrome (FS) is a geriatric problem characterized by reduced functional ability and impaired adaptation function caused by the decline in various body systems, as well as increased vulnerability to various kinds of stressors, which reduce a person's functional performance [1], [2]. The incidence of FS is around 7% at the age above 65 years and 30% at the age above 80 years. In a study of Caucasians, women suffer from FS more than men (7:5), whereas, in African Americans, it is twice as common as Caucasians (14:7) [3], [4], [5]. Pathophysiologically, FS is a process of decreasing multi-system ability due to dysregulation by the ageing process, which begins with physiological changes due to age, disease, lack of activity, and inadequate nutritional intake [3], [4], [5], [6], [7], [8], [9].

Specific nutrients such as leucine, Vitamin D, and omega 3 show a role in the skeletal muscle system and have been the latest object of research, either as a single supplement or in combination [10], [11]. Omega 3 is proven to stimulate skeletal muscle protein synthesis [12]. Omega-3 is an essential fatty acid derived from α linolenic acid synthesis which is metabolized into the form of eicosapentaenoic acid, and docosahexaenoic acid has been shown to act as an anti-inflammatory and in the development and maintenance of neurocerebral function [12], [13]. Omega-3 has an anabolic role in skeletal muscle, reduces pro-inflammatory cytokines, and increases insulin sensitivity [14]. Omega-3 also stimulates skeletal muscle protein synthesis by increasing transcription and expression of the p70SK gene through the mTOR pathway and inhibiting mitochondrial breakdown by reducing reactive oxygen species (ROS) [15], [16].

FS prevention in the elderly is essential because it can improve the quality of life. FS prevention in old age is crucial because it can enhance the quality of life. However, studies on nutritional intake as prevention in this disorder have contradictory results. This study was aimed to explore the effect of omega-3 supplementation on muscle mass, handgrip strength, and physical performance in the elderly community in Palembang, Indonesia.

Methods

This study is an open clinical trial, to assess the potential of omega-3 supplementation on muscle mass, handgrip strength, and physical activity of geriatric patients. The inclusion criteria was participants are patients over 60 years of age who have been assessed by a geriatric specialist with FS (based on the clinical criteria of Fried *et al*., namely if there are three or more of the criteria consisting of weakness, reduced walking speed, decreased physical activity, and weight loss) [3] and had agreed to participate in this study.

The exclusion criteria were that the research subjects were regularly taking anti-inflammatory drugs both steroids and non-steroid, anti-platelet aggregation, anti-coagulants, omega-3 supplementation, consumption of fish oil, and foods rich in omega-3 such as consumption of deep-sea fish (such as tuna fish more than 100 g/day, salmon fish more than 100 g/day, walnuts more than 200 g/day, mackerel fish more than 100 g/day, milk more than 500 ml/day, and beef more than 100 g/day) [17] and Vitamin D at least 1 month before the study. Furthermore, the research subjects used implanted devices (such as knee or hip endoprosthesis, pacemakers, and walking sticks), history of blood vomiting, bloody/black bowel movements, hemorrhagic stroke, decompensated hypertension heart disease, decompensated coronary artery disease, cancer with or without chemotherapy or radiotherapy, and malnutrition. The drop out criteria were participants who dropped out of drugs for more than 1 day, passed away, suffered from hypersensitivity reactions or drugs side effects such as gastrointestinal bleeding so that the drug administration should be stopped. As many as 40 subjects participated in this study, besides this study has received the approval of the ethics committee of Faculty of Medicine, Universitas Sriwijaya (No. 129/kptfkunsrirsmh/2019).

Omega-3 is given as much as 1.2 g once a day for 12 weeks orally. Muscle strength was evaluated using Bioelectrical Impedance Analysis (Omron, Singapore). Meanwhile, the muscle strength was assessed with a muscle dynamometer (Kern, Singapore). Physical performance was measured by walking speed evaluation (how long it takes to walk 6 m long). Data management and analysis were performed using SPSS version 20.0 for Windows with a significance limit of $p < 0.05$ with a paired t-test for numerical scale variables. If there is a possibility of a vast difference between before and after treatment, then an interim analysis can be performed.

Results

Based on gender, seven subjects were male and 33 female with a mean age of 66.325 (± 4.87) years. The last education research subjects were eight high schools and 32 universities. As for comorbid diseases, it was found 30% and 70% absent in the study subjects. The research subjects had a mean body mass index of 22.0158 (± 3.46) kg/m^2 (Table 1).

Table 1. Characteristics of participants

Characteristics	n (%)	Mean (± SD)	Median (min-max)
Age (years)			
60–65 years old	21 (52.5)	66.325 (±4.87)	65 (61.00-80.00)
66–70 years old	12 (30.0)		
>71 years old	7 (17.50)		
Gender			
Male	7 (17.5)		
Female	33 (82.5)		
BMI			
Underweight	7 (17.5)	22.0158 (±3.46)	21.51 (15.98-30.45)
Normal weight	25 (62.5)		
Overweight	8 (20.0)		
Education			
High school	8 (20)		
Colleges	32 (80)		
Comorbid disease			
Yes	12 (30.00)		
None	28 (70.00)		

BMI: Body mass index

Omega-3 supplementation has only shown potent efficacy in improving muscle strength in geriatrics. Omega-3 supplementation did not show significant improvement in muscle mass and gait ability in elderly community (Table 2).

Table 2. Changes in muscle mass, grip strength, and walking speed before and after treatment

Characteristics	Treatment		
	Before	After	p-value*
Muscle mass			
Mean (SD)	38.86 (±5.48)	38.87 (±5.48)	0.32
Median (min-max)	38.2 (32.2–54.3)	38.2 (32.2–54.3)	
Handgrip			
Mean (SD)	25.1 (±5.11)	26.2 (±5.16)	0.00
Median (min-max)	24.0 (15–37)	24.5 (18–38)	
Walking speed			
Mean (SD)	7.06 (±1.58)	7.07 (±1.24)	0.53
Median (min-max)	6.68 (5.30–12.00)	6.05 (3.87–9.10)	

*t-test dependent, $p < 0.05$

Discussion

Muscle strength is the capacity of the muscles to handle a load [18]. Contraction begins with an overlap between actin and myosin filaments. Actin and myosin filaments are arranged in periodic bands called sarcomeres and their repeating sequence forms pipes called fibers. Motor neurons innervate the muscles. The combination of a single motor neuron and muscle fibers innervated by the branches is called a motor unit. Changes in muscle strength due to age can be affected by the number and size of muscles that turn into atrophy and hypoplasia, a decrease in slow and fast motor units and the presence of atrophy in type I and II muscle fibers. This can occur because actin and myosin are essential components in muscle contraction. A decrease in protein synthesis and an increase in muscle protein degradation affect muscle strength in elderly [19].

The study results showed that omega-3 supplementation improved muscle strength in geriatric patients but did not show an increase in muscle mass and the ability to increase walking speed. The effect of omega-3 supplementation has improved handgrip strength, but it takes longer consumption time and a higher dose to achieve maximum results. The improvements that are seen are new to the handheld which is one of the slight motor movements, where there is no need for the intervention of large muscles to move the handgrip, in contrast to walking which requires intervention and the presence of multiple large muscles, which will require longer consumption times and higher doses to achieve significant improvements and changes in muscle strength.

Research by Hutchins-Wiese *et al*. [20] and Krzyminska-Siemazko *et al*. [21] states that there is no significant relationship between omega-3 supplementation on muscle mass. In contrast to the research of Smith *et al*. [22] and Logan and Spriet [23] giving omega-3 ± 3 g for 3–6 months was proven to increase muscle mass, in this study, the dose of omega 3 was only 1.2 g, of course, it is still lower than the above studies which gave up to 3 g. Increasing the dose and duration of consumption and adherence to consumption are vital factors for improving muscle strength and improving functional mobility.

Research by Smith *et al*. [22] stated that omega-3 supplementation increases muscle strength. This study treated geriatric subjects aged 60–85 years with omega-3 supplementation as much as 4 g/day for 9 months. The results of this study indicate an improvement in hand gripping ability and an increase in muscle mass. This study shows that omega-3 supplementation provides optimal results when given sufficiently large doses and long follow-up times.

An *in vitro* study, Magee *et al*. [24] have shown that the administration of omega-3 to myoblasts increases the transcription of gene expression in the peroxisome proliferator-activated receptor gamma coactivator 1 alpha pathway so that apoptosis is inhibited and the synthesis of actin and myosin proteins increases. Elevated mitochondrial biogenesis will increase citrate synthase activity by maintaining oxidative capacity (oxidative phosporylation). Then, ROS emission will decrease and it will induce catabolic reactions in musle cells. Increased mitochondrial biogenesis as an energy producer and myosin actin in muscle cells increases muscle strength and is proven through this study [25], [26], [27], [28].

Research by Logan and Spriet [23] states that omega-3 supplementation increases walking speed. The shorter travel time is related to the role of omega-3 acting on the signaling pathway of the mitogen-activated protein kinase cascade during proliferation, the expression of extracellular signal-regulated kinase (ERK) 1/2 will increase and then enter into the nucleus so that the target gene transcription also increases as a result of increased muscle cell proliferation and survival [29], [30], [31]. Furthermore, this pathway inhibits the differentiation of muscle cells to become dominant type I but type II dominance [32]. Type I muscle cells have slow-twitch type fiber, while type II is fast-twitch type, so when type II is dominant, walking speed increases. Type II is a fast fiber with a higher glycolytic potential, low oxidative capacity, and faster response than type I (slow fiber). There is a conversion from type II to type I fibers because of the potential adaptive response. In elderly muscles, the decrease in type I and II fibers results in muscle function changes, especially muscle speed and strength [33], [34]. Based on this study, omega-3 supplementation is beneficial for muscle strength improvement so that clinicians can consider the use of omega-3 in clinical work.

Conclusions

Omega-3 supplementation improves muscle strength but does not increase muscle mass and physical performance for elderly community.

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