Relations Between Protein Energy Intake, Micronutrient Intake, and the Grip Strength of Elderly Women

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Abstract

Background: Handgrip strength is one of the measurements and assessments of muscle function. It is essential to maintain muscle strength to keep mobility and productivity. The decrease of this muscle function is caused by many factors including nutritional status, nutrient intake, and physical activity.

Aim: This research aims to analyze the relations of protein-energy intake, micronutrient intake (calcium, iron, zinc), and the grip strength of elderly women.

Settings and Design: This study uses a cross-sectional study design with a sample of 65 respondents.Samples were selected with purposive sampling technique. The samples in this study were obtained from elderly women in the work area of the Poris Gaga Lama Health Center, Tangerang City, Banten. **Methods and Material:**. Data of protein and energy intake were obtained using 2x24h food recall form, and data of micronutrient intake was taken using SQ-FFQ form. Hand grip strength was taken with a digital handgrip dynamometer. **Statistical analysis used:** Pearson and Spearman correlation test. **Results:** The results of the analysis of protein energy intake as well as the micro-nutrient intake of respondents were mostly sufficient based onthe recommended nutritional adequacy rate for elderly women. There were relations between energy intake (p= 0.0001, r=0.75), protein intake (p=0.0001, r=0.80), calcium intake (p=0.0001, r=0.74), iron intake (p=0.0001, r=0.62), and zinc intake (p=0.0001, r= 0.77) as well as the grip strength. **Conclusions:** There are relations between protein energy intake, micronutrient intake and the grip strength of the elderly. The elderly are advised to consume macronutrients such as protein energy and micronutrients to increase muscle mass.

Keywords: Elderly, Hand grip strength, Muscle Mass, Macronutrients, Micronutrients

Key Messages:

For the elderly, it is very necessary to prevent the risk of decreasing muscle strength by increasing protein energy intake, intake of micronutrients (calcium, iron, zinc), and doing regular physical activity for at least 30 minutes once a day.

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Introduction

The increasing number of elderly populations in Indonesia will indirectly bring challenges in various fields. Particularly in the health sector, the challenge is how to maintain the quality of life and health status of the elderly. In other words, the elderly must be able to achieve "optimal aging" in their life. Based on the data of National Health Statistics Agency in 2015, the morbidity rate for elderly in urban or rural areas have continued to increase from the year 2013.The morbidity rate for elderly living in urban areas was 23.12%.In 2014 it increased to 23.25% and in 2015 it became 26.89%. With increasing age, a person's physiological function will decrease due to the aging process.[1]One of the main features of functional changes in the bodies of elderly is in the musculoskeletal system. Changes that occur in the musculoskeletal system are changes in body composition, with reduced skeletal muscle mass (sarcopenia) and loss of muscle strength (dynapenia).[2]

Sarcopenia can occur due to aging, and it not only causes a decrease in skeletal muscle mass, but also causes physical dysfunction, which leads to decreased productivity, decreased mobility, and an increased risk of falls and fractures. Sarcopenia has been associated with a higher incidence of falls in women. Nearly 28-35% of people aged 65 and over fall each year, which increases to 32-42% for those who are over 70 years of age.[3] Muscle strength is the ability of muscles to contract to withstand loads in maximum effort. Muscle strength is generated from the combination of power and muscle quality. Handgrip strength is one of the ways of assessing functional capacity and a diagnostic parameter for sarcopenia to measure muscle strength.[4] The impact of weak handgrip strength is associated with weak lungs, which can increase the risk of stroke, and create a much higher risk of having a heart attack.[5] Other studies have also stated that low muscle tone is closely associated with weak lung function at over 50 years of age. Due to the fact that muscle strength is related to skeletal muscles, aging in skeletal muscles also affects respiratory muscle function.[6] Therefore, it is essential to improve health and increase muscle strength for functional abilities in daily life. Several factors affect hand strength in the elderly, including age, gender, nutritional status, muscle mass, and nutrient intake.

One factor which affects a person's nutritional status and muscle mass is the intake of nutrients. The availability of nutrients in the body also affects the ability of muscles to contract. Energy intake is a contributor of energy for muscle growth. Protein intake will increase the availability of amino acids to stimulate muscle protein synthesis and branched-chain amino acids (BCAAs), especially leucine, which acts as a strong stimulator of protein synthesis through the pathway of mammalian target of rapamycin (mTOR) protein kinasey.[7] If it can be controlled, an increase inprotein synthesis will increase muscle mass, strength, and muscle function. Apart from calories, protein intake is also closely related to muscle strength. Protein is a chemical substance in food that is formed from a series of amino acid chains. Protein is needed by the body to build and maintain body cells such as muscle cells, bones, enzymes, and red blood cells. In addition to protein energy intake, micronutrients, including calcium, also play a role in muscle movement, muscle contraction, and relaxation. The presence of calcium in the blood can maintain muscle movement, just like other micronutrients, namely iron and zinc. Iron itself is associated with the formation of red blood cells which will deliver nutrients into the muscles. These results are in line with a research conducted by Taket al., (2018) which found that iron intake had a correlationwith hand grip strength in both men and women. Zinc intake is also needed in the elderly for the health of bone, where zinc is needed to activate aminoacyl- tRNA syntheses in osteoblast cells and stimulate cellular protein synthesis. There are many factors that influence the grip strength of a person's hand, and so the researchers are interested in analyzing the relationship between protein energy intake, micronutrient intake (calcium, iron, and zinc), and hand grip strength in elderly women.

Subjects and Methods

This research was conducted in December 2019, using a cross-sectional design with a population of all elderly who regularly came to Posbindu, the Poris Gaga Lama Community Health Center, specifically Posbindu Mawar 2 and 3. Activities that were routinely carried out at Posbindu Mawar 2 and 3 include weighing, height measurement, and blood tests of cholesterol; uric acid and blood sugar mentioned in the Elderly Health Card. Samples were selected by purposive sampling technique in order to obtain samples that matched predetermined criteria. The sample criteria in this study were female, aged 45-80 years (pre-elderly and elderly according to WHO (2015)), physically fit, willing to be the sample in this study, and able to communicate well. The sample was calculated using the guarantee test formula, which resulted in a total of 65 people.

The protein energy intake data were obtained by interviewing respondents with the 2x24 hour recall method, and the interviews were not conducted consecutively. In this study, the interviews were conducted alternatively, with one working day and one day off, then the intake data collected were

processed using Nutrisurvey 2007 software, then compared with the nutritional adequacy rate (AKG, 2019). Meanwhile, the data for intake of micronutrients (calcium, iron, zinc) for the last 1 month used the SQ-FFQ form.All intake results were converted in 1 day and the amount was in milligrams. After that, it was calculated using Nutrisurvey 2007 software and compared with the nutritional adequacy rate (AKG, 2019).

Measurement of hand grip strength used a digital Camry Electronic handgrip dynamometer model EH101-37 and the measurements were made with the dominant hand. Based on the modification of Roberts et al., (2011) and Mani et al., (2019)., the measurement of hand grip strength is carried out three times with the body position of sitting upright using the following steps: asking respondents to sit in a chair in an upright position and both feet flat on the floor, then choose which hand is dominant. The shoulder should be away from the body (abduction), while the elbow should be straight with arm hanging at the side and the unmeasured hand resting on thigh. Respondents are asked to take a deep breath. When exhaling while holding the breath, the respondents should use a dynamometer handgrip tool with all of their might for 5 seconds. During the test, neither the hands nor the dynamometer should touch the body or other objects. Measurements were carried out 3 times on the dominant hand with a rest period of 30 seconds between each experiment. The score assessment was obtained from the highest value out of the3 measurements. The values were then categorized as weak, strong, and very strong according to the age of the subject and the standard of hand grip strength. In this research, all subjects used their right hand as their dominant hand. The Handheld Strength Standard was based on the Electronic Hand Dynamometer Instruction Manual CAMRY, NC, (2014) (Table.4). The data collected then went through the editing, coding, entry, and processing stages. Data were analyzed using the Pearson and Spearman Correlation test. This research has received ethical approval from the Research Ethics Commission of EsaUnggul University Health, Jakarta in the form of the Statement of Ethical Approval Number: 0506-19.500/DPKE-KEP/FINAL- EA/UEU/ XI/2019 on November 2019.

Results

The results of the study as listed in Table 1 showed that out of the 65 subjects in this study, most (66.2%) were 45-59 years old, with the youngest aged 45 years old and the oldest 80 years old. Subjects in the Posbindu, the work area of the Poris Gaga Lama Community Health Center who were selected as respondents mostly worked as housewives, namely 49 people (75.4%). The average hand grip strength of the subjects in this study was 26.31 kg. The weakest hand grip strength was 11.30 kg and the strongest hand grip strength was 38.90 kg. The hand grip strength of 10 subjects (15.4%)

belonged in the weak category, while 38 subjects (58.5%) had normal hand grip strength, and 17 subjects had strong hand grip strength (26.2%).

Table 2, illustrates the results of the frequency distribution based on nutrient intake. It was found that the average energy intake of the subjects in this study was1906.90 kcal with a minimum energy intake of 1049.3 kcal and a maximum energy intake value of 2883.8 kcal. From the results of the study, the average frequency distribution of the protein intake of respondents in this study was 68.18 grams, with a minimum protein intake value of 24.60 grams and a maximum intake of 98.8 grams. In addition to protein energy intake, this study also identified the intake of micronutrients, including calcium, iron, and zinc in elderly women in Posbindu, the work area of Poris Gaga Lama Health Center. The average calcium intake of respondents was 1091.79 milligrams (mg) with a minimum intake of 572.5 mg and a maximum intake of 1264 mg. Iron intake was also identified in this study. It was found that the average iron intake of respondents was 12.07 mg with a minimum intake of 3.60 mg and a maximum intake of 22.6 mg. The intake of micronutrients (zinc) was also analyzed in this study. It was found that the average zinc intake of respondents was 9.20 mg with a minimum intake of 5.20 mg and a maximum intake of 13.2 mg.

The results of the correlation analysis test in Table 3 showed that the relationship between energy intake and hand grip strength was significant, as indicated by the value of $p = 0.0001$ ($p \leq 0.05$) and the value of the correlation coefficient (r) = 0.75 which indicated a strong positive relationship pattern. Similar to energy intake, significant results regarding the relationship between protein intake and hand grip strength were obtained, as indicated by a value of $p = 0.0001$ (r) = 0.8 which meant that it showed a strong positive pattern of relationship between variables. The analysis of the bivariate test was then used to analyze the relationship between micronutrient intake (calcium, iron, and zinc) and hand grip strength. It was found that there was a significant relationship between intake of calcium, iron, zinc, and handgrip strength with each value. $p = 0.0001$ with a correlation coefficient of (r) = 0.74 for calcium, (r) = 0.62 for iron, and (r) = 0.77.

Table 1: Respondents Frequency Distribution Based on Respondent Characteristics

Variables	Samples		Min-Max	*Mean ± SD*
	n	%		
Age				
Middle age (45-59 years)	43	66.2	45-80	57.26 ± 8.51
Elderly (60-74 years)	19	29.2		
Old (75-90 years)	3	4.6		
Profession				
Laborer	7	10.8		
Teacher	2	3.1	-	-
Housewife	49	75.4		
Entrepreneur	7	10.8		
Hand Grip Strength				
Weak	10	15.4		
Normal	38	58.5	11.30-38.90	26.71. ± 6.95
Strong	17	26.2		

Table 2. Characteristics of Respondents Based on Nutrient Intake

Variable	Min-Max	Mean ± SD
Energy (kcal)	1049.3-2883.8	1906.90 ± 475.36
Protein (gram)	24.60-98.8	75.00 ± 2.47*
Calcium (mg)	572.5-1264	1133 ± 18.42*
Iron (mg)	3.60-22.6	12.07 ± 4.89
Zinc (mg)	5.20-13.2	9.20 ± 1.89

Table 3. Bivariate Analysis WithCorrelation

Variable	Hand Grip Strength (n=65)	
	Correlation (r)	*p-Value*
Energy Intake	0.75	0.0001*
Protein Intake	0.80	0.0001*
Calcium Intake	0.74	0.0001*
Iron Intake	0.62	0.0001*
Zinc Intake	0.77	0.0001*

*there is a significant relationship ($p \leq 0.05$)

Table 4.Elderly Woman's Hand Grip Strength Standard

No	Age	Category		
		Weak (kg)	Normal (kg)	Strong (kg)
1	45-49	<18.6	18.6-32.4	>32.4
2	50-54	<18.1	18.1-31.9	>31.9
3	55-59	<17.7	17.7-31.5	>31.5
4	60-64	<17.2	17.2-31.0	>31.0
5	65-69	<15.4	15.4-27.2	>27.2
6	70-99	<14.7	14.7-24.5	>24.5

* *Electronic Hand Dynamometer Instruction Manual* CAMRY, NC,2014.

Discussion

In this study, all 65 respondents whose grip strength was measured followed the recommendations of the American Society of Hand Therapists in Roberts (2011), namely by using the dominant hand.[8] This is because the volume of the bicep and deltoid muscle of the dominant handis higher than the non-dominant hand.[9] In the study, all respondents used the right hand to assess the hand. From the analysis results, respondents in this study who had weak handgrip strength were on average aged 59 years and over, while respondents who had stronghandgrip strength were on average agedunder59 years (pre-elderly).

Nutritional intake is also an important factor in muscle strength.From the results of the analysis, it was found that respondents who had energy intake in the category of severe, moderate, and mild deficiency also had weak hand grip strength,whilerespondents with sufficient energy intake category had the most normal hand grip strength, namely 31 respondents. Meanwhile, respondents within the category of excessive energy intake had the strongest hand grip strength, namely 13 respondents. As evidenced by the correlation test, this study finds that there is a significant relationship between energy intake and hand grip strength in elderly women according tothe correlation coefficient value which shows a strong positive relationship between the two variables. For example,the more significant the energy intake, the stronger handgrip strength that will be produced. This is because energy intake plays a role in stimulating the increase of muscle mass. The energy contained in food will be oxidized in cells with the help of oxygen. This process is the energy required for muscle contraction so that the muscles provide maximum power. Likewise, if the energy intake is low, the energy reserves will be low, so the forces do not have the fuel to perform muscle contraction.

Protein in the elderly is very important because it plays a role in protein synthesis, although in the elderly, its function has decreased. Many of the respondents' cells were damaged, while respondents whose protein intake was in the category of severe deficiency had the weakest handgrip strength, namely nine respondents.

The results of this study are in line with previous studies conducted.[10] In the elderly aged 51 at What We Eat America (WWEIA), it was found that hand grip strength was positively associated with protein consumption of ≥25 grams per day. This is because protein intake will increase the availability of amino acids to stimulate muscle protein synthesis and branched chain amino acids (BCAAs), especially leucine, which acts as a strong stimulator of protein synthesis through thepathway of mammalian target of rapamicyn (mTOR) protein kinase. If controlled, an increase in protein synthesis will increase muscle mass, strength, and muscle function. The imbalance between protein supply and protein requirements can result in a loss of skeletal muscle mass, which results in the elderly experiencing loss of muscle mass and muscle strength as well as physical limitations to perform daily physical activities.

One of the nutrients that affects muscle endurance and strength is mineral, which includes calcium, iron, and zinc. The results of the analysis showed that respondents who had calcium intake in the deficit category also had the weakest hand grip strength, namely nine people, while respondents who had sufficient calcium intake had the most normal hand grip strength, namely 17 people. This is because low calcium intake can increase the rate of lipogenesis and inhibit lipolysis, consequently leading to increased adiposity. Increased fat infiltration and decreased fat in skeletal muscle can cause muscle atrophy.[11]Sufficientcalcium intake will play a role in the interaction of muscle protein, namely actin and myosin when contracted. It is thought that chemical stimulation from the nerve endings to the muscle fibers that causes the contraction is the release of calcium ions from their storage in cells. This calcium ion stimulates the ATP-ase enzyme in myosin which results in the breakdown of ATP which produces energy and the formation of cross-links between actin and myosin called Actomyosin as well as the occurrence of muscle contraction. This muscle contraction is what moves the bones, for example, the contraction of the muscles in the hands which makes the muscles and bones become easy to move and are able to lift weights on the hands. This is what causes the hand grip strength to be strong.

Iron in the body acts as a means of transporting oxygen and transporting electrons in cells, and it plays a role in various enzyme reactions in body tissues. Iron itself is associated with the formation of red blood cells which will deliver nutrients into the muscles. The results of the correlation test in this study indicated that there was a relationship between iron intake and hand grip strength with a strong positive relationship between the two, meaning that the more adequate the iron intake, the stronger the strength of the hand grip. These results are in line with a research conducted by Tak et al., (2018) which found that iron intake had a relationship with hand grip strength in both men and women. In this study, respondents with sufficient iron intake and strong hand grip strength due to sufficient iron intake can form hemoglobin and carry oxygen when the muscles work. If the oxygen is

in a small amount and it is not enough to produce energy, the body will produce energy by producing lactic acid which will cause muscle fatigue. It seems to have strengthened the respondents' muscular endurance so that they could hold the load on the hand muscles correctly. Likewise, in respondents with iron deficiency, due to a decrease in the amount of O2 in the body, there is a decrease in the amount of ATP produced as a raw material for muscle contraction, which results in muscle contraction and the weakening of muscle strength .

Zinc (Zn) is a mineral that is spread in the body and in almost all cells. Most of the zinc are in the liver, pancreas, kidneys, muscles, and bones. In this case, zinc contributes to normal cell function and helps the process of muscle growth. The correlation analysis in this study showed that there was a relationship between zinc intake and hand grip strength with the relationship between the two having a strong positive pattern, meaning that the more adequate the zinc intake, the stronger the strength of the hand grip. There has not been any research related to the relationship between zinc intake from food and handgrip strength. There are only studies that have analyzed the relationship between serum zinc and hand grip strength. In this study, it was found that respondents with sufficient zinc intake also had the most normal grip strength, namely 35 people,while17 people had strong hand grip. This is in accordance with the theory which states that zinc contributes to resistance of the bone, where muscles attach. The contraction of the skeletal muscles will move the bones that they are attached to. Thus, if the zinc intake is not sufficient, the bones and the muscle contraction in the hand for gripping are not optimal. However, for respondents who had zinc intake in the deficiency category, there was no difference in the strength of their handgrip, namely, three people had weak grip strength, and three others had normal handgrip strength. And this also seems to be due to insufficient zinc intake associated with lower serum zinc concentrations, which results in damaged muscle functions, including decreased muscle strength and the tendency to get more tired due to reduced energy during peak muscle performance.

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