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by Hermina Sukmaningtyas

ORIGINAL ARTICLE

Correlation Between Serum Magnesium Level and Sarcopenia Occurence in the Elderly Women: Study with Dual-energy X-ray Absorptiometry (DXA)

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ABSTRACT

Introduction: Elderly people usually have decreased in muscle mass, muscle strength or physical performance. These disease are known to be sarcopenia. They also would have lost several essential minerals including magnesium. In age-related diseases including sarcopenia, aging and Mg deficiency have been correlated to excessive production of free radicals and low grade inflammation. The purpose of this study is knowing the correlation between serum magnesium with sarcopenia occurence in elderly women. **Methods:** A cross sectional design observational study was performed on 28 respondents aged 60 years and above by performing serum magnesium test, muscle mass examination, muscle strength examination and physical performance examination. **Results:** Based on Dual Energy X-ray Absorptiometry (DXA) assessment, gait speed test, and hand grip test, using Asian Working Group Of Sarcopenia (AWGS) algorithm; 11 women were sarcopenia and 17 women were non sarcopenia. This study described higher mean Mg level for sarcopenia group (2.37±0.28 mg/dl) than non sarcopenia group (2.20±0.19 mg/dl). There are no signficant difference in magnesium serum level between samples with sarcopenia and non sarcopenia (p>0,05). **Conclusion:** The result show that there are no correlation between serum magnesium level with sarcopenia.

Keywords: Elderly, Sarcopenia, Serum magnesium level, DXA, AWGS algorithm

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INTRODUCTION

Loss of muscle mass, muscle strength, and decrease in physical performance which are known as sarcopenia are correlated with aging process (1). Several minerals including magnesium are known to have a role in muscle metabolism and muscle function which it will improve muscle metabolism, muscle function, and reduce muscle spasms. Aging is also associated with magnesium (Mg) deficit. Both aging and Mg deficiency have been correlated to production of free radicals and low grade inflammation which are also present in several age-related diseases, such as vascular and metabolic conditions, as well as frailty, muscle loss and sarcopenia (1,2).

Sarcopenia is characterized by decrease of muscle mass, strength and function. European Working Group on Sarcopenia in Older People (EWGSOP) in 2010 defined sarcopenia as "a syndrome characterized by progressive and generalized loss of skeletal muscle mass and strength with a risk of adverse outcomes such as physical disability, poor quality of life and death" (3,4). These complex pathogenesis may involve aging, mitochondrial dysfunction, oxidative stress, inflammatory reactions, apoptosis, and many other pathways (5,6). Skeletal muscles which account for 40% of the human body weight contain 25-30% of the total magnesium. The decrease of Mg might cause muscle cells alterations through increased oxidative stress and impaired intracellular calcium homeostasis. Thus, it has been estimated that Mg status may affect muscle performance, due to Mg's key role in energetic metabolism, transmembrane transport and muscle contraction and relaxation. Total plasma Mg concentrations (MgT) are tend to be constant in healthy

subjects throughout life and do not change with aging but in situations correlated to a subclinical Mg deficit, the initial compartments that seems to be related are the intracellular compartment and the ionized fraction of serum Mg, while a decrease of the bound and complexed total serum Mg (hypomagnesemia) may appear at a later stage, related to more long-lasting Mg depletion. Inflammation and oxidative stress are related to chronic Mg deficiency, as well as the increased incidence of chronic diseases associated to aging. A chronic, low-grade inflammation and oxidative stress are conditions present in many age-related diseases including sarcopenia, and have been postulated to be related in the aging process itself (2).

A method for analyzing body composition and also the gold standart for assessment of bone mineral density are by using Dual-energy X-ray absorptiometry (DXA). Amount of appendicular SMI (ASM) could be estimated by using the bone-free and fat-free mass of the arms and legs as assessed with DXA (7-10). The diagnosis of sarcopenia requires measurements of muscle mass, muscle strength, and physical performance. Consensus of the Asian Working Group of Sarcopenia (AWGS) are the current operational definitions and diagnostic strategy of sarcopenia in Asia which was the modification from the European Union Geriatric Medicine Society (EUGMS) and the European Working Group on Sarcopenia in Older People (EWGSOP) (11-13).

MATERIALS AND METHODS

Samples

We performed a cross-sectional study by evaluating elderly women attending several elderly club in Semarang, Indonesia. This study began by identifying the subjects which fulfill the inclusion criteria using Asian Working Group Of Sarcopenia (AWGS) algorithm. Actually, there were 75 women have come to participate in this study but only twenty eight women aged 60 years and older were fulfilling the criterias. Physical performance and muscle strength were tested onsite, while muscle mass using DXA machine and Mg serum level were performed at the SMC Telogorejo Hospital Semarang, Indonesia. The approval and ethical clearance from the Faculty of Medicine Diponegoro University (Undip), Indonesia was attained upon commencement of the study [ETHICAL CLEARANCE No.181/ EC/ KEPK/ FK-UNDIP/ V/ 2019].

Collecting Magnesium Blood Serum

Participant's blood were collected and analyze with Auto Hematology Analyzer. Results were measure in mg/dl and the normal value of magnesium serum level were 1.8-2.6 mg/ dl.

Measuring Muscle Strength

We used handgrip strength for evaluating muscle strength by using a Jamar hand-held dynamometer. The subjects were sit in a chair and during the examination, the subject was strongly encouraged to perform the best possible force. The best of 3 attempts with each hand were averaged for the analysis. AWGS's criteria which states low grip strength as <26 kilogram (kg) for men and <18 kg for women were used in this study

Measuring Muscle Performance

Muscle performance were measured by usual gait speed test without deceleration by asking the subjects to walk with normal and comfortable steps. Walking courses are 4 or 6 meters (m) long. Two marking signs were place in 8 m distance and setting up the stopwatch on 2 m after the first sign and 2 m before the second sign. These provide 2 m for acceleration zone, 4 m for walk time section and 2 m for deceleration zone. 4 m walked time were measured by stopwatch. We use AWGS's consensus which stated 0.8m/sec as the cut-off.

Measuring Body Composition

A fan-beam dual energy x-ray absorptiometry (Lunar iDXA, GE Healthcare) was performed to evaluate total body fat mass and total bone free lean mass (kg) by using standard image analysis protocols. The amount of lean mass from both arms and legs is the definition of appendicular lean mass (ALM). Appendicular skeletal muscle mass (ASM) is the amount of muscle mass of the four limbs from a DXA scan, and a skeletal muscle mass index (SMI) is defined as ASM/height2 (kg/m2). We use AWGS consensus which recommends cut off value for men as 7.0 kg/m2 and for women (DXA) as 5.4 kg/m2.

Definition Of Sarcopenia

European Working Group on Sarcopenia in Older People (EWGSOP) defines sarcopenia based on gait speed, handgrip strength and muscle mass. They defined three clinical conditions: (a) Presarcopenia (defines by low muscle mass with normal muscle strength or normal physical performance), (b) sarcopenia (defines by low muscle mass with low muscle strength either low physical performance), and (c) severe sarcopenia (defines when all three criterias are included: low muscle mass, low muscle strength and low physical performance).

In this study we only categorize the subjects as sarcopenia (defines mainly by low muscle mass with or without low muscle strength and low physical performance) and non sarcopenia. Since our subjects were all Indonesian (Asian) women, we only use the cut off points from AWGS consensus for women (muscle mass <5.4kg/m2, muscle strength <18 kg, speed test <0.8 m/s). We compared magnesium serum level between sarcopenia and non sarcopenia group. In addition we also compared magnesium serum level between ages 60-65 years and > 65 years old.

Statistical Analysis

Descriptive analytical method were used to describe characteristic of the participants (age, body weight

and height) and variables (magnesium serum level and sarcopenia occurence) from all samples. Samples were categorized to sarcopenia and non sarcopenia group and were shown as tabulation of data. Concurrenty, magnesium serum level were shown as numerical data (median, mean, and Deviation Standard). Analytical data were shown as tables and graphs.

Non parametric statitical analysis were done in this study. Mann Whitney statistical test were performed to see the mean differences between two independent groups (magnesium serum level in sarcopenia and non sarcopenia group and also magnesium serum level in subjects aged over 65 years and aged 60-65 years old). Pearson-ChiSquare analysis were performed to see the corelation between 2 independent groups (sarcopenia occurence in group of subject aged over 65 years and aged 60-65 years). A $p \leq 0.05$ was defined as statistical significance for all tests. Statistical analyses were performed by SPSS version 17.0.

RESULTS

Study Characteristics

Primary data of this study were magnesium serum level, skeletal muscle index, hand grip test and gait speed test data which were collected from the chosen participants (elderly women) which fulfill the inclusion and exclusion criterias during January-June 2019. During this period of time there were 28 participants : 13 participants were aged 60-65 years (46.4%) and 15 subjects were aged >65 years (53.6%).

From these participants, 11 subjects were categorized in sarcopenia group (39.3%) and 17 subjects were categorized in non sarcopenia group (60.7%). In sarcopenia group there were 4 subjects aged 60-65 years and there were 7 participants aged >65 years. Meanwhile in non sarcopenia group there were 9 subjects aged 60-65 years and 8 subjects aged >65 years (Fig.1/ Table 1). In this study there were no correlation between sarcopenia occurence with group of subjects aged 60-65 years and over 65 years (p>0.05).

Table I : Variable Correlation between Group Of Ages, Mg Serum Level and Sarcopenia

	Sarcopenia (n=11) (mean, median, min,max)	Non Sarcopenia (n=17) (mean, median, min,max)	*p*
	f/%	f/%	
Age			
60-65 yo	4 (14.3%)	9 (32.1%)	0.390
>65 yo	7 (25%)	8 (28.6%)	
Magnesium (Mg) Serum Level	(2.37, 2.32, 1.91, 2.97)	(2.20, 2.15, 1.95, 2.60)	0.104

Table above shows there were no correlation between sarcopenia occurence with group of subjects aged 60-65 years (n=4) and over 65 years (n=7) (p>0.05). It also shows that here were no difference between mean value of magnesium serum level in sarcopenia (n=11) and non sarcopenia group (n=17) (p>0,05)

In sarcopenia group, magnesium serum level were 1.91-2.97 mg/dl (median 2.32 and mean 2.37 mg/dl). Concurrently, in non sarcopenia group magnesium serum level were 1.95-2.6 mg/dl (median 2.15 and mean 2.20 mg/dl). There were no difference between mean value of magnesium serum level in sarcopenia and non sarcopenia group (p>0,05) (Table 1, Fig.1).

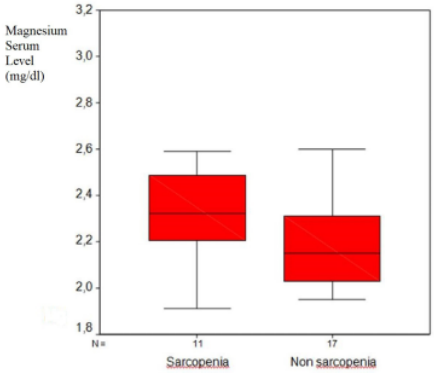

Fig. 1 : Magnesium Serum Level Difference Between Sarcopenia and Non Sarcopenia Group. In sarcopenia group, Mg serum level were 1.91-2.97 mg/dl (median 2.32 and mean 2.37 mg/dl). Meanwhile, in non sarcopenia group Mg serum level were 1.95-2.6 mg/dl (median 2.15 and mean 2.20 mg/dl). There were no Magnesium serum level below normal range in all participants.

In group of subject aged 60-65 years, magnesium serum level were 1.91-2.5 mg/dl (median 2.2 and mean 2.19 mg/dl). Meanwhile, in group of subject aged > 65 years, magnesium serum level were 1.95-2.97 mg/dl (median 2.31 and mean 2.33) (Table 2, Fig.2). There were no Magnesium serum level below normal range in all participants, and the distribution pattern were random (Fig.3). There were no difference in mean value of magnesium serum level in group of subjects aged 60-65 years and subjects aged >65 years (P>0.05).

Table II : Correlation Between Magnesium Serum Level with Ages

	Age 60-65 y.o (n=13) (mean, median, min, max)	Age >65 y.o (n=15) (mean, median, min, max)	*p*
Magnesium (Mg) Serum Level	(2.19, 2.20, 1.91, 2.50)	(2.33, 2.31, 1.95, 2.97)	0.128

Table above shows There were no difference in mean value of magnesium serum level in group of subjects aged 60-65 years (n=13) and subjects aged >65 years (n=15) (P>0.05)

DISCUSSION

In this study, there were 11 participants (39%) categorized as sarcopenia group and 17 participants (61%) categorized as non sarcopenia group. In sarcopenia group: there were 4 participants aged 60-65 years and 7 subjects aged > 65 years. This result match the study by *Baumgartner*, et al which stated sarcopenia prevalence were 13-24 % on group aged 65-70 years and 50% on aged 80 years (8).

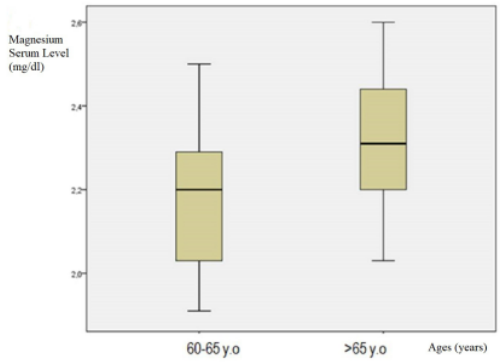

Fig. 2 : Magnesium Serum Level Difference Between Group Aged 60-65 y.o and >65 y.o. Subjects aged 60-65 years, Mg serum level were 1.91-2.5 mg/dl (median 2.2 and mean 2.19 mg/dl). Meanwhile, subjects aged > 65 years, Mg serum level were 1.95-2.97 mg/dl (median 2.31 and mean 2.33).

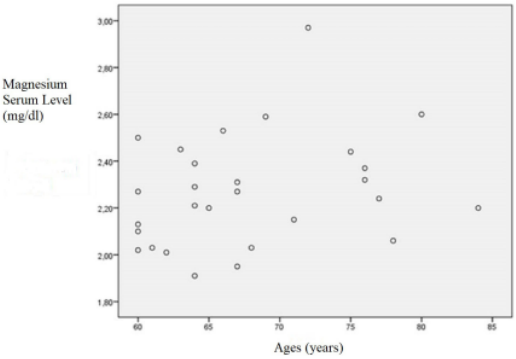

Fig. 3 : Distribution Pattern of Magnesium Serum Level According to Ages. Scatter plot graph showing there were no Mg serum level below normal range in all participants, and the distribution pattern were random.

According to the age of participants, all of the subjects have normal range on serum magnesium level (mean value 2.27 µg/dl). In sarcopenia group, mean value were 2.37 µg/dl and in non sarcopenia group were 2.20 µg/dl. This study showed normal magnesium serum level both in sarcopenia and non sarcopenia group.

This study used Dual X-ray energy absorptiometry (DXA) which is the gold standard tool in measuring muscle mass (8-12). That was one of the strength of this sudy. The other was, there were no study in southeast asia (especially Indonesia) conducted before which correlate between magnesium serum level with sarcopenia occurance. The only study which correlates sacopenia with magnesium serum level was study by *Ter Borg*, et al which were conducted in Maasricth, Netherland. Other study, such as IN-CHIANTI study by *Dominguez*, et al which were conducted in Italy only correlates one of the sarcopenia component (muscle strength). In our study, there were no significant difference on mean magnesium serum level between sarcopenia group and non sarcopenia group. These may be caused by the laboratory parameter used in this study were total magnesium serum. Meanwhile the parameter of *Intracelluler free* Mg (Mgi) and *free* Mg (Mg ion) which possibly may be reduced were not checked.

Our study doesn't match IN-CHIANTI study by *Dominguez*,et al which observed one of the Sarcopenia component (muscle strength). On IN-CHIANTI study, participants with higher serum magnesium level would get higher results on handgrip strength, knee extension torque, and ankle extension test. Result from this study showed that there was correlation between magnesium serum level with muscle strength in elderly. This possibly caused by magnesium consentration effect in mitochondria on muscle which is very crusial for elderly (14-16).

Our study match the study by Ter Borg, et al which showed that there were no difference in serum magnesium level consentration between sarcopenia and non sarcopenia group. This might be caused by serum magnesium level that were tightly regulated by urine excresion, bone deposit and digestive system. It means that serum magnesium level were not too sensitive for detection of difference in small magnesium intake rather than the large one (15-17).

Our study also shows the relation between serum magnesium level with aging which tended to be in normal range. Our study match *Barbagallo*, et al which stated that Total magnesium plasma consentration (MgT) are remain constant in healthy subjects throughout life and aging do not affect them (2).

Mean serum magnesium level in our study also does't have significant difference between group of participants aged over 65 years and subjects aged 60-65 years old. This possibly caused by the magnesium serum parameter used in our study was total magnesium serum which were on normal range. Meanwhile *Intracelluler free* Mg (Mgi) and *free* Mg (Mg ion) were not checked. This was one of the limitations in our study. The other limitation was, unlike the study by Verlaan, et al, our study did'nt perform the food questionnaire (type of food, intake frequencies, food minerals) for the participants (18) which can be confounding factor in this study.

CONCLUSION

Our study shows the following conclusions :

1. There were no differences on mean value of magnesium serum level between sarcopenia and non sarcopenia group.

2. There were no differences in mean value of magnesium serum level between group of participants aged over 65 years and aged 60-65 years.

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