

## Original Research Article

# Association between mid upper arm and calf circumferences and cognitive function in elderly

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## ABSTRACT

**Background:** Nutritional status has been associated with cognitive function in elderly. Several anthropometric measurement, including mid upper arm circumference and calf circumference are recognized as effective means to assess nutritional status, as they have good correlation with body mass index. This study aimed to identify the association between MUAC, CC and cognitive function in elderly population.

**Methods:** This cross sectional study involved 71 elderly subjects aged more than 60 years old. We recruited subjects from Medan Helvetia district because it has the largest aging population in Medan, North Sumatera, Indonesia. The Cognitive function was assessed using montreal cognitive assessment test Indonesian version (MoCA-INA) and visual cognitive assessment test. To examine the association between MUAC, CC and cognitive function using Kruskal Wallis test and Fisher Exact.

**Results:** There were 42 females and 29 males. The mean age was  $68.68 \pm 6.35$  years. The mean MUAC was  $24.3 \pm 3.25$  cm and CC was  $31.5 \pm 2.45$  cm. There was no association between MUAC and MoCA-INA ( $p=0.215$ ) and VCAT ( $p=0.062$ ). There was an association between CC and MoCA-INA ( $p=0.040$ ) and VCAT ( $p=0.019$ ).

**Conclusions:** There was an association between calf circumference and cognitive function while mid upper arm circumference was not. Compared to BMI, calf circumference can predict sarcopenia in the elderly. Elderly with functional impairment and impaired mobility may show a decrease in calf circumference. Sarcopenia is often associated with brain atrophy in the elderly.

**Keywords:** Calf circumference, Cognitive, Elderly, Medan, Mid upper arm circumference

## INTRODUCTION

Aging is progressive processes of physical, cognitive and psychological decline in a person.<sup>1</sup> Elderly have several problems, especially health problem. Cognitive impairment is a problem that often experienced by elderly.<sup>2</sup> The prevalence of mild cognitive impairment in Indonesia in 2010 was around 32.4% of total elderly population.<sup>3</sup> Some factors induce decreased cognitive function such as infections, hypertension and cardiovascular disease, impaired socioeconomic function and nutritional deficiencies. Volkert et al stated that

malnutrition often occurs in elderly. It is estimated that about 50% of elderly are malnourished.<sup>4</sup> The central nervous system is an organ that is very sensitive to impacted because of low nutritional intake, so decreasing in nutrition will cause brain function disorders, one of them is cognitive function.<sup>5</sup>

Several tests are used in assessing an elderly person who has nutritional disorders or malnutrition. Research conducted by Selvaraj et al in 2017 states that measurements of mid-upper arm circumference (MUAC) and calf circumference have a good correlation with body

mass index (BMI) and be used to assess elderly nutrition.<sup>6</sup> This study aimed to identify the association between mid upper arm circumference, calf circumference and cognitive function in elderly population

## METHODS

### Study sample

This study sample was taken from subjects in Puskesmas Helvetia at Medan Helvetia district, the largest aging population in Medan, North Sumatera, Indonesia from February 2020 to April 2020. This study using consecutive sampling techniques. This study subject consisted of 71 elderly aged  $\geq 60$  years with inclusion criteria are able to speak Indonesian, cooperative, able to read and write, and willing to take part in the study by signing a research-informed consent. The exclusion criteria of this study are they who had stroke previously; dementia and aphasia.

### Study design

This study was a cross-sectional design. This study assessed cognitive function using MoCA-INA and VCAT. MoCA-INA has been developed as a brief cognitive screening tool to detect mild-moderate cognitive impairment with a normal score  $\geq 26$ .<sup>7</sup> VCAT is a visual-based tool that may more suitable for multicultural, multilingual societies around the world with a normal score of 23-30, a mild cognitive impairment score was 18-22 and a dementia score was less than 18.<sup>8</sup> MUAC and CC are assessed by tape meter. MUAC divided into 3 groups,  $<21$  cm, 21- $<22$  cm and  $\geq 22$  cm. CC divided into 2 groups,  $<31$  cm and  $\geq 31$  cm.

### Statistical analysis

Data from the research were analyzed using the SPSS (statistical product and science service) to determine the association between MUAC, CC and cognitive function. The relationship between MUAC, CC with cognitive function was analyzed with Fisher exact test and Kruskal Wallis.

## RESULTS

There were 71 subjects in the Medan Helvetia district from February to April 2020 who participated in this study. There were 42 females (59.2%) and 29 males (40.8%) out of 71 subjects. The mean age of the subjects was  $68.68 \pm 6.35$  years. Most of the subjects belonged to age group of 60-64 years. The education level of most subjects was senior high school, which were 29 people (40.8%). The demographic characteristic is shown in (Table 1).

There was 61 subjects with abnormal MoCA-INA score, 45 subjects had MUAC  $\geq 22$  cm, 10 subjects had MUAC

21- $<22$  cm, and 6 subjects had MUAC  $<21$  cm. There was 10 subjects with normal MoCA-INA values, 5 had MUAC  $\geq 22$  cm, 4 subjects had an upper arm circumference 21- $<22$  cm, and 1 subject had an upper arm circumference  $<21$  cm.

**Table 1: Demographic characteristic (n=71).**

Parameters	N	%
<b>Age (years), mean<math>\pm</math>SD</b>	68.68 $\pm$ 6.35	
<b>Age group (years)</b>		
60-64	23	32.4
65-69	16	22.5
70-74	18	25.4
>75	14	19.7
<b>Sex</b>		
Male	29	40.8
Female	42	59.2
<b>Education</b>		
Primary	13	18.3
Junior high school	18	25.4
Senior high school	29	40.8
Bachelor	11	15.5
<b>Occupation</b>		
Unemployment	5	7
Retired	18	25.3
Entrepreneur	28	39.4
Housewife	20	28.3
<b>Mid upper arm circumference (cm), mean<math>\pm</math>SD</b>	24.3 $\pm$ 3.25	
<b>Group of mid upper arm circumference (cm)</b>		
<21	7	9.9
21- $<22$	14	19.7
$\geq 22$	50	70.4
<b>Calf circumference (cm), mean<math>\pm</math>SD</b>	31.5 $\pm$ 2.45	
<b>Group of calf circumference (cm)</b>		
<31	29	40.8
$\geq 31$	42	59.2

Kruskal Wallis test results showed p value 0.215 ( $\alpha < 0.05$ ), meaning that there was no relationship between MUAC and the MoCA-INA score. The relationship between MUAC and MoCA-INA score can be seen in (Table 2). There was 38 dementia subject when examined with VCAT, 29 of whom had MUAC  $\geq 22$  cm, 4 subjects had MUAC of 21-  $<22$  cm and 5 subjects had MUAC of  $<21$  cm. There was 20 subjects with MCI, 14 had MUAC  $\geq 22$  cm, 5 subjects had MUAC of 21- $<22$  cm and 1 subject had MUAC  $<21$  cm. There was 13 subjects with normal score, 7 had MUAC  $\geq 22$  cm, 5 subjects had MUAC 21-  $<22$  cm, and 1 subject had MUAC  $<21$  cm. Kruskal Wallis test results showed p value 0.062 ( $\alpha < 0.05$ ), meaning that there was no relationship between MUAC and VCAT score. The relationship between MUAC and VCAT score can be seen in (Table 3).

There was 61 subjects with abnormal MoCA-INA score, 33 people had CC  $\geq 31$  cm and 28 subjects had upper calf circumference  $< 31$  cm. There was 10 subjects with normal MoCA-INA score, 9 had CC  $\geq 31$  cm and 1 subject had CC  $< 31$  cm. Fisher Exact test results showed p value 0.040 ( $\alpha < 0.05$ ), meaning that there was a relationship between CC and MoCA-INA score. The relationship CC and MoCA-INA score can be seen in (Table 4).

**Table 2: Association between MUAC and the MoCA-INA score.**

Parameters	MoCA abnormal	MoCA normal	P value
<b>MUAC (cm)</b>			
<21	6	1	0.215
21-<22	10	4	
$\geq 22$	45	5	
<b>Total N (%)</b>	61 (85.9)	10 (14.1)	

Kruskal Wallis test, significant  $p < 0.05$

**Table 3: Association between MUAC and the VCAT score.**

Parameters	VCAT Dementia	VCAT MCI	VCAT Normal	P value
<b>MUAC (cm)</b>				
<21	5	1	1	0.062
21-<22	4	5	5	
$\geq 22$	29	14	7	
<b>Total N (%)</b>	38 (53.5)	20 (28.2)	13 (18.3)	

Kruskal Wallis test, significant  $p < 0.05$

**Table 4: Association between calf circumference and the MoCA-INA score.**

Parameters	MoCA abnormal	MoCA normal	P value
<b>Calf circumference (cm)</b>			
<31	28	1	0.215
$\geq 31$	33	9	
<b>Total N (%)</b>	61 (85.9)	10 (14.1)	

Fisher Exact test, significant  $p < 0.05$

**Table 5: Association between calf circumference and the VCAT score.**

Parameters	VCAT Dementia	VCAT MCI	VCAT Normal	P value
<b>Calf circumference (cm)</b>				
<31	16	7	0	0.062
$\geq 31$	22	13	13	
<b>Total N (%)</b>	38 (53.5)	20 (28.2)	13 (18.3)	

Kruskal Wallis test, significant  $p < 0.05$

The results of the VCAT examination of 38 dementia subjects, 22 had calf circumference of  $\geq 31$  cm and 16 subjects had calf circumference of  $< 31$  cm. Of the 20 subjects with MCI, 13 people had calf circumference  $\geq 31$  cm and 7 subjects had calf circumference  $< 31$  cm. Of the 13 subjects with normal results, all had calf circumference  $\geq 31$  cm. Kruskal Wallis test results showed p value 0.019 ( $\alpha < 0.05$ ), meaning that there was a relationship between the calf circumference and the MoCA-INA score. The relationship between the calf and the VCAT score can be seen in (Table 5).

## DISCUSSION

This was a cross-sectional study to determined the relationship between the MUAC, CC and cognitive function in elderly who visit the Helvetia Medan health center or those who located in the working area of the Helvetia public health center in Medan. Subjects who participated in the study was 71 elderly who met the inclusion and exclusion criteria. Subjects who met the criteria measured for MUAC, CC and cognitive function tests using the MoCA INA and VCAT.

Subjects in this study were 71, of which the majority of the elderly are women, 42 subjects. This is in line with data published by Badan Pusat Statistik (BPS) in 2016 which showed that more female elderly than male elderly with a percentage of 9.2% of the elderly are female and 8.19% of the elderly were male.<sup>9</sup> Research conducted by Hai et al on the relationship between nutrition and cognitive impairment in the elderly in China revealed that more female had cognitive impairment than men.<sup>10</sup> Research conducted by Kandiah et al in 2015 also showed older women are more than men.<sup>8</sup> There was more elderly women than men because women have a greater life expectancy than men. One of the reasons women have a greater life expectancy than men is because of the hormone estrogen. The hormone estrogen has several properties that make women are more protected from diseases such as cardiovascular disease, namely estrogen provides protection to endothelial cells and increases hemostasis in blood vessels. This puts women at a lower risk of developing cardiovascular disease. Then estrogen can also increase antioxidants which are protective for blood vessels.<sup>11</sup>

The mean age in this research was  $68.68 \pm 6.35$  years. This is in line with research conducted by Christiandari in 2018 on the relationship between nutritional status and cognitive function, where the mean age was 68.81 years, but Christiandari did not divide the age group in the study.<sup>5</sup> Research conducted by Alzahrani and Alamri in 2017 stated that the average age of the elderly who experience malnutrition is 69.5 years. examined its nutritional status.<sup>12</sup> Most of the respondents' education level was Senior High School, namely 40.8%. This is in line with research conducted by Lestari, et al. In 2016 which states that subjects with secondary education are the highest level of education in the elderly studied and at

the same time are the largest educational group with cognitive disorders.<sup>13</sup> The opposite result obtained from the research of Costa et al. Research by Costa et al stated that only 35.9% of the elderly population in Brazil has been educated for more than 4 years.<sup>14</sup> According to Lievre et al, education affects cognitive function. This is because patients who receive better education have a better cognitive reserve than those with low education.<sup>15</sup>

Most types of work of respondents were self-employed, 28 people (39.4%). Research conducted by Rambe and Fitri in 2017, stated that the most occupation of the elderly in the study was not working as much as 36.1%.<sup>16</sup> Nurizky et al in 2017 stated that most elderly works were employee retirement.<sup>17</sup> The mean upper arm circumference of the subjects is  $24.3 \pm 3.25$  cm with the largest group with an upper arm circumference  $\geq 22$  cm, namely 70.4%. These results are consistent with research conducted by Tsai et al in 2012, which states that the average upper arm circumference of their study subjects who are also elderly is 24.8 cm. The results of Tsai et al stated that most of their study subjects, namely 76.9%, had an upper arm circumference of  $\geq 22.5$  cm.<sup>18</sup> The average calf circumference of the subjects is  $31.5 \pm 2.45$  cm, with the largest group having an upper arm circumference  $\geq 31$  cm, namely 59.2%. The results were similar to the research conducted by Kim et al it stated that the average calf circumference of their research subjects is  $34.8 \pm 2.4$  cm.<sup>19</sup> There was no relationship between MUAC and both MoCA-INA and VCAT. This finding is different with research by Lee et al they concluded that there is an association between decreased upper arm circumference and dementia in the elderly in Korea. Association between decreased upper arm circumference with nutritional disturbances that have an impact on metabolic disorders, especially carbohydrate metabolism in the elderly, which can accelerate neurodegeneration.<sup>20</sup> Taylor et al also stated in a study conducted in 7 countries that there was a relationship between decreased upper arm circumference and dementia.<sup>21</sup> This finding is same with study by Rivian et al in 2020 that concluded that there is no difference in the size of MUAC in elderly with cognitive impairments and those without. This study also concluded that there is no relationship between mid-upper arm circumference and cognitive function. The average mid-upper arm circumference in this study was 24.3 cm. According to the cut-off value in the elderly malnutrition screening or MNA is normal if the arm circumference is 22 cm and in this study on average it is still within normal values.<sup>22</sup> This is one reason there is no relationship between mid-upper arm circumference and cognitive function. Tsai et al in a study conducted in Taiwan in 2012 stated that the upper arm circumference is better for assessing the health status of the elderly at 12 months evaluation.<sup>18</sup> In this study the assessment took once, which is maybe causes no significant relationship between mid-upper arm circumference and cognitive function.

There was a relationship between CC and both MoCA-INA and VCAT. Research conducted by Kim et al in 2018 states that there is a relationship between calf circumference and cognitive function in the elderly.<sup>19</sup> Research conducted by Tsai et al also stated that calf circumference is a better measurement than upper arm circumference and BMI to assess nutritional status in the elderly.<sup>18</sup> Calf circumference is one of the simple anthropometri that is more representative in assessing malnutrition in the elderly. Compared to BMI, CC can predict sarcopenia in the elderly. Sarcopenia is often associated with brain atrophy in the elderly. Elderly with functional impairment and impaired mobility may show a decrease in calf circumference. Although the average calf circumference of the research subjects was normal. But from the percentage of the elderly who experience cognitive impairment, about 40% of the elderly have calf circumference that is below normal. There was an association between Calf Circumference and cognitive function while mid upper arm circumference was not. Compared to BMI, calf circumference can predict sarcopenia in the elderly. Sarcopenia is often associated with brain atrophy in the elderly.

## CONCLUSION

There was an association between calf circumference and cognitive function while mid upper arm circumference was not. Compared to BMI, calf circumference can predict sarcopenia in the elderly. Elderly with functional impairment and impaired mobility may show a decrease in calf circumference. Sarcopenia is often associated with brain atrophy in the elderly.

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