Correlation between Handgrip Strength and Oral Hygiene in Indonesian Older Individuals Living in Urban Area

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Abstract

This study aimed to determine handgrip strength (HGS), oral hygiene index (OHI), and the correlation between those variables in the elderly living in the urban area in Serang City, Banten Province, Indonesia.

This analytic correlational cross-sectional study included 54 individuals aged ≥ 60 years old. HGS was assessed using an electronic hand dynamometer and categorized into three clinical groups: strong, normal, and weak. OHI was measured using the O'Leary plaque index before and after subjects brushed their teeth. The correlation between the variables was analysed using Spearman's Rank Correlation test.

The subjects were 33 women (61.1%) and 21 men (38.9%). The mean of HGS and range of OHI were (19.66 ± 8.06) kg and (20.0 – 93.8) %, respectively. Subjects with weak HGS have a lower percentage of plaque score reduction (0.00% to 6.50%) between toothbrushing activity compared to normal HGS group. The Spearman's Rank Correlation Test result was r=0.004 (p<0.05).

There was a significantly negative correlation between HGS and OHI in the elderly at Lebak Indah Housing Estate, Serang City, Banten Province, Indonesia. The stronger HGS indicates a lower plaque index score or a better OHI, and vice versa.

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Introduction

Oral hygiene is essential for the elderly in order to maintain good oral health and prevent tooth loss.[1] However, the aging process causes a decrease in muscle function due to decreased muscle strength. Therefore, it can be challenging for the elderly to maintain functional activities such as brushing their teeth. Papa, et al.[2] found that muscle strength can decrease by about 12-15% after a person reaches the age of 50 years.

Hand grip strength (HGS) is an indicator of muscle strength which can be measured with a hand grip dynamometer, a quick and easy method. HGS is not only affected by age, but also by several factors such as gender, physical activity, and comorbidity. Low HGS can predict a decrease in activities of daily living.[3–7] A weak HGS may be associated with the inability to maintain oral hygiene.[3,4,8] A poor oral condition might have a physical and psychological impact on the quality of life, especially in the elderly.[9,10] An extra effort is needed to keep the optimal oral hygiene such as brushing teeth. The toothbrush needs to be gripped firmly, to be able to lift plaque and sticky food debris.[4,11,12]

Studies regarding the correlation between HGS and oral hygiene found conflicting results. Komulainen et al.[11] suggested that the ability to maintain oral hygiene in the elderly is not associated with HGS, but is affected by the functional status related to performing daily activities. On the other hand, a more recent study by Sari et al.[4] suggested that maintaining HGS in the elderly ensures an adequate grip on the toothbrush handle and could remove plaque and debris more effectively. These previous studies only evaluated the OHI once, without comparing the effect of tooth brushing on the OHI. Therefore, this study aimed to investigate the correlation between HGS and OHI by evaluating the reduction of plaque score between toothbrushing

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activities in elderly living in urban area.

Materials and methods

Study Design

This was a cross-sectional study with an analytic correlational method. The subject was selected by consecutive sampling technique who live in Lebak Indah Housing Estate, Serang City, Banten Province, Indonesia. Ethical approval were obtained from the Research Ethics Committee Universitas Padjadjaran (No.156/UN6.KEP/EC/2022). The participants were informed that their participation in the study is voluntary and they could leave the study at any stage. All data were only accessible to the principal investigator.

Inclusion and Exclusion Criteria for Participants

This study included elderly aged ≥ 60 years old, who were willing to participate and followed all procedures by signing informed consent. Subjects who were unable to brush their teeth independently, and had not been vaccinated against COVID-19 were excluded. Subjects who had fewer than six teeth, neurological disorders (Parkinson's disease and stroke), joint inflammatory disease on the hands (osteoarthritis), and systemic disease (diabetes mellitus) were also excluded.

Interview

All participants were interviewed for demographic profile, health records, level of physical activity, and toothbrushing frequencies. Physical activities were divided into three categories based on their level of intensity, namely light, fair, and vigorous.[13] Vigorous-intensity activities were defined as performing activities such as running, digging, and hiking in a minimum average of 75-150 minutes a week. Cycling on primarily flat terrain without hills and doing household chores with an average duration of 150-300 minutes a week were considered fair-intensity activities. Besides the criteria above, the activities belonged to light intensity.[13–15]

Hand Grip Strength Measurement

HGS was determined using an electronic hand dynamometer (EH101, CAMRY, South El Monte, CA). Before the examination, the operator had adjusted the electronic hand dynamometer settings by the age and gender of the subject. The subject was seated comfortably with the back, pelvis, and knees forming an angle of 90°.[16] The dynamometer was placed in the subject's dominant hand. The subject straightened their arms down beside the body and took a deep breath and gripped the electronic hand dynamometer firmly and quickly to maximum strength within 5 seconds. The procedures were repeated at 60-second intervals. The highest score was recorded.[7] Table 1 depicts the categories of HGS into three clinical groups based on the reference value of the equipment used i.e., strong, normal, and weak.[4]

Age	Men			Women		
	Weak	Normal	Strong	Weak	Normal	Strong
60-64	< 30.2	30.2–48.0	> 48.0	< 17.2	17.2-31.0	> 31.0
65-69	< 28.2	28.2-44.0	> 44.0	< 15.4	15.4-27.2	> 27.2
70-99	< 21.3	21.3-35.1	> 35.1	< 14.7	14.7-24.5	> 24.5

Table 1. Hand Grip Strength Normal Value for Elderly (kg).

Oral Hygiene Index Measurement

The O'Leary plaque index was assessed twice to calculate oral hygiene before and after the subject brushed their teeth. The subjects were instructed to rinse their mouths with an antiseptic solution before the examination. Then the disclosing agent was applied to the surface of the subjects' teeth, followed by the instruction to rinse their mouth with water. Plaque was detected by visually inspecting the surface of the tooth stained by the disclosing with a dental mirror. The stained area was marked with a plus sign (+), while a minus sign (-) indicates the absence of plaque. The plaque score was assigned for each mesial, distal, buccal, and lingual tooth surface on all teeth.

Subjects were instructed to brush their teeth as they normally do on a daily basis for one minute. Each subject was provided with the same brand of toothbrush and toothpaste. After subjects finished brushing their teeth, the disclosing agent was applied. then the plaque index score was assessed again to calculate OHI after brushing teeth. The O'Leary plaque index value was obtained by calculating the number of tooth areas stained with the disclosing agent, divided by the number of tooth surfaces in the mouth, and multiplied by 100%. Clinical criteria and O'Leary Plaque Index scores are shown as followed; scores 0-20% (good), 21-40% (fair), 41-60% (poor), and >60% (very poor).[17,18] Subsequently, the plaque index score was divided into two categories, good-fair and poor-very poor. The value of plaque index score before and after brushing teeth was observed by

analysing the median, minimum and maximum range values of the differences in each subject based on HGS categories.

Statistical Analysis

All the data in this study were evaluated using IBM Statistical Product and Service Solutions version 25 (IBM, Armonk, NY). The Chi-square test was used to determine the correlation between the subject's characteristics and study variables. Exploratory analysis using the Kolmogorov-Smirnov test showed that the data were not normally distributed.

Non-parametric analysis using Spearman's Rank Correlation test was used to analyse the correlation between the two variables. Statistical analysis was performed at a significance level of $p < 0.05$.

Variable	N=54 n (%)	HGS Categories n (%)			p	OHI Categories n (%)		p
		Weak	Normal	Strong		Good-Fair	Poor-Very Poor	
Age					*0.033			*0.047
60-64 years	20 (37.0)	10 (50.0)	10 (50.0)	0 (0.0)		7 (35.0)	13 (65.0)	
65-69 years	20 (37.0)	13 (65.0)	7 (35.0)	0 (0.0)		6 (30.0)	14 (70.0)	
70-99 years	14 (25.9)	13 (92.9)	1 (7.1)	0 (0.0)		0 (0.0)	14 (100.0)	
Sex					*0.045			0.971
Female	33 (61.1)	23 (69.7)	10 (30.3)	0 (0.0)		8 (24.2)	25 (75.8)	
Male	21 (38.9)	13 (61.9)	8 (38.1)	0 (0.0)		5 (23.8)	16 (76.2)	
Level of Education					0.206			*0.017
Elementary school	9 (16.7)	8 (88.9)	1 (11.1)	0 (0.0)		1 (11.1)	8 (88.9)	
Junior high school	9 (16.7)	8 (88.9)	1 (11.1)	0 (0.0)		1 (11.1)	8 (88.9)	
High school	31 (57.4)	19 (61.3)	12 (38.7)	0 (0.0)		7 (22.6)	24 (77.4)	
College	5 (9.3)	1 (20.0)	4 (80.0)	0 (0.0)		4 (80.0)	1 (20.0)	
Occupation					0.846			0.928
Housewives	27 (50.0)	19 (70.4)	8 (29.6)	0 (0.0)		7 (25.9)	20 (74.1)	
Retired Civil Servants	19 (35.2)	12 (63.2)	7 (36.8)	0 (0.0)		4 (21.1)	15 (78.9)	
Entrepreneurs	8 (14.8)	5 (62.5)	3 (37.5)	0 (0.0)		2 (25.0)	6 (75.0)	
Physical activity					*0.001			0.101
Light	33 (61.1)	32 (97.0)	1 (3.0)	0 (0.0)		0 (0.0)	33 (100.0)	
Moderate	21 (38.9)	4 (19.0)	18 (33.3)	0 (0.0)		13 (61.9)	8 (38.1)	
Tooth brushing					0.715			*0.047
2x/day	44 (81.5)	30 (68.2)	14 (31.8)	0 (0.0)		13 (29.5)	31 (70.5)	
1x/day	10 (18.5)	6 (60.0)	4 (40.0)	0 (0.0)		0 (0.0)	10 (100.0)	

Table 2. HGS and OHI in Elderly Based on Subjects Characteristics Data.
n = counts, %: percentage, HGS: hand grip strength, OHI: oral hygiene index, *p-values < 0.05 are considered to be significant.

Results

A total of fifty-four elderly were included in this study. The number of women (61.2%) was higher than men. The mean ± SD of HGS was 19.66 ± 8.06 kg, and the OHI range was (20.0 – 93.8) %. Table 2 shows that the age group of 60-64 years (50.0%) had the highest proportions of normal HGS.

Conversely, the age group of 70-99 years had the highest proportions of weak HGS (92.9%). No subjects belonged to the category of strong HGS. There was a significant difference of HGS according to the age group (p=0.03), sex, and level of physical activities. OHI was

significantly different according to age group, level of education, and toothbrushing frequencies.

The range of the plaque score reduction before and after brushing teeth and OHI categories by HGS categories are shown in Table 3. Subjects with normal HGS had higher plaque score removal (6.60-27.40%) than subjects with weak HGS. Most of the subjects with normal HGS had a good-fair OHI (72.2%). All subjects with weak HGS had poor-very poor OHI (100.0%).

Hand grip strength category	Decrease of Oral Hygiene Plaque Score (%)			Oral hygiene category (%)		n
	Median	Minimum	Maximum	Good-fair	Poor-very poor	
Weak	3.10	0.00	6.50	0 (0.0)	36 (100.0)	36
Normal	9.25	6.60	27.40	13 (72.2)	5 (27.8)	18
Strong	0.00	0.00	0.00	0 (0.0)	0 (0.0)	0

Table 3. The Decrease of Oral Hygiene Plaque Index (O'Leary Plaque Index Score) on The HGS. n = counts, %: percentage, cross tablature.

The results of Spearman's rank correlation found a significantly negative correlation between HGS and OHI (r=-0.389**, p=0.004). These results indicate that subjects with a stronger HGS had a lower plaque score and higher OHI level. These correlations are described in the following scatter plot diagram (Figure 1).
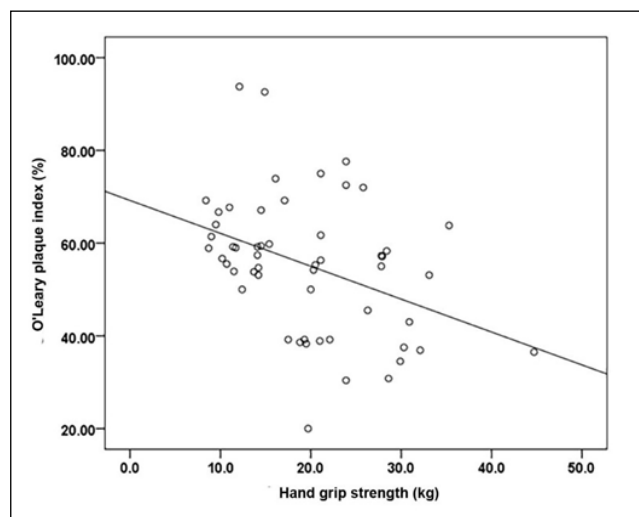
Figure 1. Scatter plot diagram of the correlation between HGS and OH.

Discussion

Serang City is the capital of Banten province and occupies the 4th most populous

area in Banten province. In 2021, the population census found that the number of people lived in Serang City was 704,618. Meanwhile, the number of people aged 60 years and above was 43,917 or 6.23% of the total population.[19] In this study, data of fifty-four elderly live in Lebak Indah Housing Estate, Serang City, Banten Province, Indonesia was analyzed.

The current study indicates that as the age increases, the HGS will decrease ($p<0.05$). A study conducted by Ong et al.[20] on the elderly population aged 60-85 years in Singapore, showed a similar result. The study found a negative relationship between grip muscle strength and aging. Aging can cause a decrease in muscle mass as the result of degenerative changes, which also causes a functional decrease in HGS.[20–22]

In this study, the female tends to have weaker HGS than the male. Previous studies on the elderly supported this result.[23] The sex difference in HGS can be explained by the greater muscle mass in men than women. The decrease in physical activities as people age is also a significant factor in the loss of muscle mass and strength. Lack of physical activity can cause muscle atrophy.[5,24,25] A study on 47 elderly aged 60-70+ years showed an increase of HGS in the group who performed a physical activity training program for 8 months.[26]

In addition, the result also shows that aging will decrease the level of oral hygiene. Komulainen et al.[11] in their study of elderly aged 75-80+ years old showed that 67% of the elderly had poorer oral hygiene. This is due to a decreased functional status in performing daily activities, resulting in the independence and self-care of the elderly such as brushing teeth.[11] The current study reveals there was a significant difference in oral hygiene and hand grip muscle strength as someone get older ($p<0.05$).

The level of education is one of factors that affect health status.[27] The present study shows an upward trend in education in subjects with good-fair oral hygiene ($p<0.05$). These results are consistent with a study performed by Basuni et al.[27] who found that the level of education is directly related to the oral hygiene index. This result is also supported by the study of Arrico et al.[28] who suggested that higher levels of education result in greater awareness of oral health.

Subsequently, in this study, subjects who brushed their teeth 2 times a day had a higher proportion of good-fair OHI. Oral hygiene is influenced by the daily toothbrushing frequency.[11] These results were also found in a study by Komulainen et al.[11] suggested that most of the subjects who had good oral hygiene were brushing their teeth twice a day.

The current study also discovered that subjects with weak HGS had a less plaque index score reduction than subjects with normal HGS. A study by Weijden et al.[29] stated that the success rate of plaque removal at a young age with relatively normal HGS was higher than that of the elderly, which was around 50-60%. Sari et al.[4] discovered that the stronger HGS was correlated with the higher amount of plaque removal. Lee et al.[30] also found that poor oral hygiene activities were significantly associated with weak HGS. Therefore, it is possible to conclude that stronger HGS will increase the effectiveness of plaque removal.

This study discovered that the elderly has relatively weaker muscle strength, which can interfere with daily activities such as brushing their teeth. Therefore, it is critical to educate the elderly on how to preserve HGS and oral hygiene in order to help them maintain their quality of life.

Our study has several potential limitations. First, this study had limited number of samples, so it could not fully represent the total sample size of all elderly people in Indonesia. Second, as the result of the small sample size, the OHI was only divided into two categories (good-fair and poor-very poor) because the number of subjects could not be matched for statistical analysis if they were divided into four categories (good, fair, poor, and very poor). Furthermore, the researcher hopes that these limitations can be taken into consideration for further research.

Conclusions

According to the findings of this study, it can be concluded that there is a significant correlation between the decreasing in HGS and OHI on the elder community live in Lebak Indah Housing Estate, Serang City, Banten Province, Indonesia. The stronger HGS indicates a lower plaque index score or a better OHI, and vice versa. Most subjects with normal HGS category have a good-fair oral hygiene and higher amount of plaque score reduction between tooth brushing

activities than subjects with weak HGS.

Acknowledgements

Declaration of Interest

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