Association between type II diabetes mellitus and hand grip strength in the elderly

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Abstract. Type II diabetes mellitus (DM) is a serious disease in Indonesia, with the highest prevalence in the elderly. Type II DM increases the risk of sarcopenia, a decline in muscle mass and strength. This study aimed to investigate an association between type II DM and hand grip strength in the elderly. It was a cross-sectional study of 164 subjects in the geriatric clinic of Cipto Mangunkusumo National Hospital. Variables assessed included type II DM as the independent variable and hand grip strength as the dependent variable. Nutritional status, age, hypertension, and dyslipidemia were considered possible confounding variables. Criteria to define hand grip strength were derived from the Asian Working Group for Sarcopenia (AWGS). Data were analyzed using a chi-square test and multivariate logistic regression. Of the subjects, 67 (40.9%) had been diagnosed with type II DM and 110 (67.1%) had low hand grip strength. There were 52 subjects (31.7%) with type II DM and low hand grip strength. Bivariate analysis showed a significant association between type II DM and low hand grip strength (OR, 2.331; 95% CI, 1.154–4.710; \( p = 0.017 \)). On multivariate analysis, variables significantly associated with low hand grip strength included type II DM (OR, 4.052; 95% CI, 1.776–9.245; \( p = 0.001 \)), nutritional status (OR, 2.369; 95% CI, 1.155–4.860; \( p = 0.019 \)), and age (OR, 3.338; 95% CI, 1.547–7.203; \( p = 0.002 \)).

1. Introduction
The proportion of elderly people in Indonesia is increasing in line with the increasing welfare of the population and improvements in health services. According to data from the Ministry of Health in 2013, out of the total Indonesian population of 248,422,956, there were 18,861,820 (7.59%) elderly people over 60 years old, a percentage that is predicted to continue to rise [1]. Consequently, the prevalence of chronic conditions affecting the elderly, such as cardiovascular disease, chronic obstructive pulmonary disease, cancer, joint disease, and type II diabetes mellitus (DM), is also expected to increase [2].

DM, in particular, is becoming a serious problem in Indonesia. In 1995, it was reported to have affected 4.5 million people, and it has been predicted to affect 12.4 million people by 2025 [3]. The greatest prevalence of DM is found among the elderly, with 4.8% of Indonesians aged 55–64 years and 4.2% aged 65–74 years reported to have it [2]. Type II DM is a chronic disease with abnormal secretion of, and resistance to, the hormone insulin, leading to hyperglycemia. The disease results in serious long-term damage to a number of organs [3,4].

DM is associated with the risk of sarcopenia, a condition of decreased muscle mass and strength, which may contribute to disability in the elderly [5]. According to Morley et al. individuals with type II DM may be particularly susceptible to sarcopenia because of diabetic peripheral neuropathy and
insulin resistance, both of which may contribute to decreased muscle mass and strength [6,7]. Upper extremity muscle strength is evaluated by measuring hand grip strength using a hand dynamometer. Several studies have reported that hand grip strength in patients with type II DM is lower than normal [8-10].

Muscle strength is influenced by various factors such as age, gender, race, and nutritional intake, as well as certain chronic conditions, such as hypertension and dyslipidemia [11-13]. A study by Bohannon reported that weak muscle strength as measured by a hand dynamometer was associated with an increased risk of early death, disability, complications, and duration of hospitalization [14]. Taekema et al. reported that low hand grip strength predicts worsening of dependency in activities of daily living and decreased cognitive function in older age [15].

A number of studies have assessed an association between type II DM and sarcopenia or hand grip strength. A study by Kim et al. in Korea reported an association between type II DM and the risk of sarcopenia at various ages [5]. However, there has not been a study evaluating this relationship specifically in elderly patients, especially in Indonesia. This study was therefore designed to investigate association between type II DM and hand grip strength in Indonesian elderly.

2. Methods
This was a cross-sectional study to determine association between type II DM and hand grip strength in elderly patients. The study protocol had been approved by the Health Research Ethics Committee of Faculty of Medicine, Universitas Indonesia-Cipto Mangunkusumo Hospital. The study subjects were 164 elderly patients who visited the Geriatric Clinic of Cipto Mangunkusumo National Hospital from June to September 2016. The hand grip strength of the subjects was measured using a Jamar dynamometer and categorized base on AWGS criteria (normal value of 26 kg for men and 18 kg for women). Nutritional status was assessed using Mini Nutritional Assessment questionnaire. Patients’ medical histories were obtained from their medical records. All statistical analysis were performed with the statistical processing program SPSS 20. Data were reported descriptively and analyzed using chi-square test. Variables with significant differences were analyzed with multivariate logistic regression (p<0.05).

3. Results
Out of the 164 subjects, aged 61 to 90 years, 90 were men and 74 were women. They were grouped for analysis according to age (60–69 years and ≥70 years), hand grip strength (low or normal, based on AWGS criteria), nutritional status (normal, at risk of malnutrition, and malnourished), and other characteristics. (Table 1)

| Variable                      | Frequency n (%) |
|-------------------------------|-----------------|
| Gender                        |                 |
| Men                           | 90 (54.9)       |
| Women                         | 74 (45.1)       |
| Age                           |                 |
| 60–69 years                   | 63 (38.4)       |
| ≥70 years                     | 101 (61.6)      |
| Type II DM                    |                 |
| Yes                           | 67 (40.9)       |
| No                            | 97 (59.1)       |
| Hand Grip Strength            |                 |
| Low                           | 110 (67.1)      |
| Normal                        | 54 (32.9)       |
Hypertension

Table 1. Continue

| Variable                  | Frequency n (%) |
|---------------------------|-----------------|
| Yes                       | 112 (68.3)      |
| No                        | 52 (31.7)       |

Dyslipidemia

| Variable                  | Frequency n (%) |
|---------------------------|-----------------|
| Yes                       | 54 (32.9)       |
| No                        | 110 (67.1)      |

Nutritional Status

| Variable                               | Frequency n (%) |
|----------------------------------------|-----------------|
| Normal                                 | 65 (39.6)       |
| Malnourished and at risk of malnutrition | 99 (60.4)       |

The mean hand grip strength results according to gender are 21.5 kg for men and 15.0 kg for women. For subjects aged 60-69 years old, the mean hand grip strength are 23.0 kg for men and 16.2 kg for women. For subjects aged 70 years old and above, the mean hand grip strength are 21.5 kg for men and 14.3 for women.

Variables were analyzed for an association with low or normal hand grip strength. On bivariate analysis, type II DM, age, and nutritional status were significantly associated with low hand grip strength (P = 0.017, P = 0.013, P = 0.025 respectively) (Table 2). These variables therefore included to multivariate analysis.

Table 2. Bivariate Analysis Results of Independent and Confounding Variables in Relation to Hand Grip Strength among 164 Elderly Subjects

| Variable                  | Normal HGS n (%) | Low HGS n (%) | OR (95% CI) | P  |
|---------------------------|------------------|---------------|-------------|----|
| Type II DM                |                  |               |             |    |
| No                        | 39 (23.8)        | 58 (35.4)     | 2.331       | 0.017 |
| Yes                       | 15 (9.1)         | 52 (31.7)     | (1.154–4.710) |    |
| Hypertension              |                  |               |             |    |
| No                        | 19 (11.6)        | 33 (20.1)     | 1.267       | 0.502 |
| Yes                       | 35 (21.3)        | 77 (47.0)     | (0.634–2.529) |    |
| Dyslipidemia              |                  |               |             |    |
| No                        | 33 (20.1)        | 77 (47.0)     | 0.673       | 0.255 |
| Yes                       | 21 (12.8)        | 33 (20.1)     | (0.340–1.333) |    |
| Age                       |                  |               |             |    |
| 60–69                     | 28 (17.1)        | 35 (21.3)     | 2.308       | 0.013 |
| ≥70                       | 26 (15.9)        | 75 (45.7)     | (1.184–4.500) |    |
| Nutritional Status        |                  |               |             |    |
| Normal                    | 28 (17.1)        | 37 (22.6)     | 2.125       | 0.025 |
| Malnourished              | 26 (15.9)        | 73 (44.5)     | (1.093–4.129) |    |

HGS, hand grip strength; OR, odds ratio; CI, confidence interval; DM, diabetes mellitus; *p < 0.05 statistical significance

Table 3. Final Model from Multivariate Analysis

| Variable                  | B    | Error Standard | OR (95% CI)     | p   |
|---------------------------|------|----------------|-----------------|-----|
| Type II DM                | 1.399| 0.421          | 4.052 (1.776–9.245) | 0.001|
| Age                       | 1.205| 0.392          | 3.338 (1.547–4.860) | 0.002|
| Nutritional Status        | 0.863| 0.367          | 2.369 (1.155–4.860) | 0.019|
4. Discussion

4.1 Sample Characteristics
Out of the 164 subjects in the study, 40.9% had type II DM, 68.3% had hypertension, and 32.9% had dyslipidemia. Only 39.6% had good nutritional status. These findings are consistent with the characteristics of geriatric patients who typically have multiple comorbidities, decreased ability to perform normal activities, and malnutrition [16].

4.2. Prevalence of Type II DM
The proportion of patients in the study with type II DM 40.9% was much higher compared to the data from the Ministry of Health for 2013, which reported type II DM in 13.8% of Indonesian elderly. However, our sample was drawn from patients attending a geriatric clinic for care, instead of population-based sample. The numbers of men and women with type II DM were quite balanced, although there were more men than women among those with DM. This is in contrast with the prevalence of type II DM among all Indonesians, which is slightly higher in women (2.3%) than in men (2.0%) [2].

4.3. Hand Grip Strength
Hand grip strength was lower in patients over 70 years of age and among women. In a meta-analysis performed by Bohannon et al. in the United States, the hand grip strength of those ≥70 years old was 38.2 kg for men and 24.2 kg for women, compared with our findings of 21.5 kg for men and 14.3 kg for women. As for those aged 60-69 years, the hand grip strength was 41.7 kg for men and 25.9 kg for women, compared with our findings of 23.0 kg for men and 16.2 kg for women. In fact, the median hand grip strength for men and women in our study was 21.5 kg for men and 15.0 kg for women. As for those aged 60-69 years, the hand grip strength was 41.7 kg for men and 25.9 kg for women, compared with our findings of 23.0 kg for men and 16.2 kg for women. In fact, the median hand grip strength for men and women in our study was 21.5 kg for men and 15.0 kg for women below the AWGS criteria of normal hand grip strength of 26 kg for men and 18 kg for women. This findings is similar to other study which found that average hand grip strength of elderly patients in Indonesia was below the average hand grip strength of elderly in the United States and other parts of Asia [17].

4.4. Association between Type II DM and Hand Grip Strength
There was a significant association between type II DM and hand grip strength in the elderly. This may be due to sarcopenia caused by type II DM as a result of insulin resistance disrupting glucose transport to the muscles. A decrease in protein synthesis results in decreased muscle mass [18,19], which can then be detected by hand grip strength measurement [19,20].

Although there have been a considerable number of studies on the association of sarcopenia with type II DM, few have directly examined this relationship in terms of hand grip strength. The results of this study are in accord with those of a study conducted by Cetinus et al. They measured hand grip strength at various ages and found that it was lower among patients with type II DM [8]. Van der Kooi et al. reported the large HELIUS study of six major ethnic groups and found a consistent association between low hand grip strength and type II DM [21]. However, neither of these studies focused specifically on the elderly.

4.5. Association between Confounding Variables and Hand Grip Strength
Among the other factors studied in our sample, there was a significant association between hand grip strength and the variables of age and nutritional status. No such association was found for hypertension and dyslipidemia. Older age was associated with a higher risk of low hand grip strength. Bohannon et al. also reported a decrease in hand grip strength with aging [12], as did Chilima and Ismail in a study of elderly patients in Malawi [22], and the AWGS Consensus Report in 2014 [17]. Similarly, poor nutritional status increased the risk of low hand grip strength, consistent with the findings of the study by Chilima and Ismail. However, they evaluated nutritional status by measuring body mass index, upper arm circumference, and arm muscle area [22], while we used the Mini
Nutritional Assessment. Both approaches to assessing nutritional status were informative in terms of classifying subjects and finding an association with hand grip strength.

No significant association was found between hypertension and hand grip strength. This is in contrast to the findings of Lukits et al. who studied subjects in the USA aged 20 to 64 years. They found that those with hypertension had lower hand grip strength than those without [23]. Han et al. reported a significant association between sarcopenia and hypertension, with those with sarcopenia having a 1.5 times greater risk for hypertension [24]. Coelho Junior et al. and Amaral et al. also found an association between sarcopenia and hypertension in elderly women [25,26].

However, few studies have investigated an association in elderly patients between hypertension and hand grip strength per se. The studies mentioned above did not specifically study hand grip strength in relation to hypertension [23,24].

As with hypertension, we found no significant relationship between dyslipidemia and hand grip strength. This conflicts with the findings of Amaral et al.’s study that a weak hand grip strength was associated with a higher risk of dyslipidemia in both men (OR = 1.31) and women (OR =1.25) [26]. Lijuan et al. reported that sarcopenia was a major risk factor for dyslipidemia in adults aged 21 to 60 years [27]. Baek et al. also reported sarcopenia as a risk factor for dyslipidemia in subjects aged 65 years and above [28].

Various studies showed that sarcopenia and low hand grip strength are risk factors for the occurrence of dyslipidemia in elderly and adult patients. Decreased muscle mass in sarcopenia may lower the basal metabolic rate, causing increased levels of sugar and lipids in the blood. If such a condition persists, it might explain the onset of chronic type II DM, dyslipidemia, or hypertension. However, the opposite mechanism as the focus of our study cannot be explained, namely how dyslipidemia might increase the risk of low hand grip strength [29].

4.6. Limitations of the Study
This was the first study to evaluate the association between type II DM and hand grip strength specifically in elderly patients, especially in Indonesia. However, there are some limitations. As a cross-sectional study, it cannot prove causality. Also, although we included several possible confounding factors, there may be other confounders influencing hand grip strength that we did not assess. Finally, using the AWGS criteria to define hand grip strength categories may not be suitable for use in Indonesians.

5. Conclusion
There was a significant association between presence of type II DM and low hand grip strength in elderly patients. Age and poor nutritional status were also significantly correlated with low hand grip strength.

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