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Handgrip Strength of Public Works Personnel in West Jakarta

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Abstract

Public Works Personnel (PWP) in Jakarta perform their routine duties manually instead of using equipment. Handgrip strength (HGS) measures maximum hand strength as a quality indicator for muscle strength and mass. Factors affecting muscle strength are age, sex, body mass index (BMI), waist circumference (WC), and hip circumference (HC). Increased fasting blood glucose (FBG) is also associated with muscle quality, muscle strength, and physical performance. This study aimed to determine the factors associated with handgrip strength in PWP. A total of 192 male PWP from the Cengkareng district were recruited by simple random sampling. The collected data were demographics, BMI, FBG, WC, HC, and HGS. Statistical analysis was done using Pearson's correlation test and multiple regression analysis. There was a significant positive correlation of BMI, WC, and HC with HGS ($p=0.006$; $r=0.20$, $p=0.009$; $r=0.19$, and $p=0.005$; $r=0.20$) and a significant negative correlation between age and HGS ($p=0.008$; $r=-0.19$) but not between FBG and HGS ($p=0.847$). Multiple regression analysis showed height, BMI, and HC positively predicting HGS (R2=0.19). Handgrip strength of public works personnel is associated with BMI, age, waist circumference, and hip circumference, but not with fasting blood glucose. Height, BMI, and hip circumference predict handgrip strength

Introduction

Personnel for the management of public infrastructure and facilities at the village level are workers who manage village public works for a given time period on the basis of a work order. The tasks of village-level public works personnel (PWP) consist of managing the infrastructure and facilities, such as streets, drains, and parks, including installed lights (Gubernur Provinsi Daerah Khusus Ibukota Jakarta, 2017). The work performed by village PWP consists mainly of intense physical activity involving the hands, such that handgrip strength is essential in their tasks. Lowering of handgrip strength may indicate reduced muscle strength, which may especially interfere with the daily activities of village PWP that consist mainly of manual labor.

Handgrip strength measures maximal hand strength and indicates muscle quality that reflects muscle strength and mass. Muscle strength refers to the ability of muscle groups to raise a given load. Low or poor grip strength is frequently associated with damaging health impacts, such as chronic disease, and is the initial sign of reduced muscle mass, limitations in physical functions, and mortality risk. Poor handgrip strength may also reduce a person's ability to perform activities of daily living and, therefore, impact quality of life (Soraya *et al.*, 2023; Nathania *et al.*, 2023). Muscle mass accounts for approximately 40% of total weight, such that knowledge of muscle mass conditions is essential in maintaining health and activities (Handayani *et al.*, 2018).

Handgrip strength may represent the strength of all muscles in the body. Several factors possibly influencing an individual's muscle strength are age, sex, and body mass index (BMI) (Soraya *et al.*, 2023). Obesity may also affect BMI. Obesity in adults is not only associated with genetic factors but also with

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environmental factors during development (Fauzi *et al*., 2022). Handgrip strength is also associated with chronic diseases such as diabetes, metabolic syndrome, and cardiovascular disease. Increased glucose concentration is also associated with disorders of muscle quality and strength, as well as physical performance (Chen *et al*., 2023). A reduction in muscle mass also affects an individual's strength and physical endurance. A combination of proteins can maintain muscle function, thereby building body strength and physical endurance (Soenyoto *et al*., 2017). In the present study, we included fasting blood glucose concentrations in the data collection to obtain more accurate measures of glucose concentrations that have not yet been influenced by food intake.

Handgrip strength may be a health indicator that provides information on a person's health (Vaishya *et al*., 2024). However, its clinical significance in determining the prevention and treatment of poor handgrip remains limited because of the still unclear etiology of muscle weakness, especially because the clinical outcomes associated with handgrip strength are extremely diverse (McGrath *et al*., 2020). The relationship between BMI and handgrip strength is still controversial, with several investigators finding a significant positive association and others reporting a non-significant relationship (Al Asadi, 2018). There are few studies on handgrip strength, especially on workers in the sanitation sector, such as public works personnel, which is why the present investigators were interested in studying this topic. The present study aimed to determine the factors associated with handgrip strength in public works personnel.

Method

This cross-sectional study involving male public works personnel in Cengkareng District, West Jakarta, was conducted from September to October 2024. The study sample was selected by simple random sampling. Calculation of the sample size for a correlation with r=0.2, Zα=0.05, and Zβ=0.1 resulted in a sample of 192 subjects who met the inclusion criterion of being male and 25-60 years old, and the exclusion criteria of having an abnormality of the hands, heart disease, pulmonary disease, and malignancies.

Measurements were obtained on height in cm, weight in kg, as well as waist circumference and hip circumference in cm. Height and weight were determined using microtoise and digital scales, respectively. BMI was calculated using the formula of weight divided by height squared. Measurement of waist and hip circumferences was done using a measuring tape. Waist circumference was determined with the subject in the upright position, at the end of a normal expiration, at the smallest abdominal circumference between the iliac crest and twelfth rib. The cut-off values for waist circumference in males and females are ≥ 90 cm and ≥ 80 cm, respectively. Hip circumference was measured using a measuring tape that was applied around the hips at the level of the symphysis pubis and the maximal gluteal circumference (Rokhmah *et al*., 2015).

Fasting blood glucose (FBG) concentration was determined on venous blood by the hexokinase method after the respondents had fasted for approximately 10 hours prior. Handgrip strength was measured with a handgrip strength dynamometer to the nearest kilogram as follows: The respondent was asked to sit down comfortably without reclining and with the feet completely relaxed. The hips and knees were positioned at a 90^0 angle, the gripping hand with the shoulder in adduction, the elbow flexed 90^0, and the forearm and wrist in the neutral position. The gripping duration was 3 seconds. The respondent gripped the instrument with the dominant hand as hard as possible, and the value indicated by the needle was recorded. In accordance with the protocol recommended by the American Society of Hand Therapists (ASHT), the recorded handgrip strength was the average of three handgrip strength tests (Nathania *et al*., 2023).

Before data analysis by means of the correlation test, the normality of the data distribution was determined using the Kolmogorov-Smirnov test. The Pearson correlation test was used for a normal data distribution, whereas for a non-normal data distribution, the Spearman correlation test was done, followed by a multiple regression analysis. Ethics approval was issued by the Ethics Committee of the Faculty of Medicine, Universitas Trisakti, under No. 033/KER/FK/08/2024.

Result and Discussion

In this study, the respondents comprised 192 male public works personnel of Cengkareng District who consisted of the villages (subdistricts) of Kedaung, Duri Kosambi, West Cengkareng, Kapuk, and Rawa Buaya. A total of 26% of the respondents were residents of Duri Kosambi, where Muslims comprised 98.4% of the population. The majority of the respondents, at 77.6% had an educational level of senior high school. Nearly all of the respondents, or 99%, were right-handed, using the right hand as the dominant one at work, and most were of the Betawi (Jakarta) ethnic group at 51.6% (Table 1).

Table 1. Demographic Data of the Respondents

Characteristic	N (%)
Village	
Kedaung	40 (20.8)
Duri Kosambi	50 (26)
Cengkareng Barat	33 (17.2)
Kapuk	43 (22.4)
Rawa Buaya	26 (13.5)
Religion	
Islamic	189 (98.4)
Christian	2 (1)
Catholic	1 (0.5)
Level of education	
Elementary school	7 (3.6)
Junior high school	29 (15.1)
Senior high school	149 (77.6)
Academy-University	7 (3.6)
Dominant hand	
Right hand	190 (99)
Left hand	2 (1)
Ethnic group	
Javanese	53 (27.6)
Betawi	99 (51.6)
Sundanese	25 (13)
Other	14 (7.3)

Legend: Other ethnicities comprised groups from Palembang, Lampung, Bima, and Kupang
Source: primary data 2024 (questionnaires and interviews with respondents)

Table 2. Respondents' Characteristics

Variable	Mean ± SD
Age (years)	40.9 ± 8.9
Height (cm)	164.6 ± 6.7
Weight (kg)	64.7 ± 13.1
BMI (kg/m^2)	23.8 ± 4.3
Waist circumference (cm)	85.4 ± 10.4
Hip circumference (cm)	96.9 ± 8.4

HGS (kg)	33.1 ± 6.9
FBG (mg/dL)	87 (64-280)*

Legend: BMI: body mass index. *FBG: fasting blood glucose, expressed as Median (Min-Max).
HGS: handgrip strength
Source: primary data (respondents' measurements)

Table 3. Analysis of the Relationship of Age, Height, Weight, BMI, Waist Circumference, Hip Circumference, and Fasting Blood Glucose Concentration with Handgrip Strength

Variable	R	P value
Age	- 0.19	0.008*
Height	0.36	0.000*
Weight	0.32	0.000*
BMI	0.20	0.006*
Waist circumference	0.19	0.009*
Hip circumference	0.20	0.005*
FBG	0.02	0.847#

*P value with Pearson's test, # Spearman's test
Source: primary data

Table 4. Multiple Regression Analysis on Handgrip Strength

Determinant	b	SE	p
Height	0.48	0.08	0.000
BMI	0.79	0.22	0.000
Hip circumference	- 0.29	0.12	0.015
Constant	- 36.98		

R^2=0,19
Source: primary data

The bivariate analysis found a significant positive correlation of BMI, height, weight, waist circumference, and hip circumference with handgrip strength (p=0.006, r=0.20; p=<0.001, r=0.36; p=<0.001, r=0.32; p=0.009, r=0.19; p=0.005; r=0.20, respectively). This showed that the larger the BMI, height, weight, waist circumference, and hip circumference, the stronger the handgrip. However, there was no significant relationship between fasting glucose concentration and handgrip strength (p=0.847). This study also found that age had a significant negative correlation with handgrip strength (p=0.011; r=-0.182), signifying that the older a person, the lower the handgrip strength (Table 3). Results of multiple regression analysis on handgrip strength are listed in Table 4.

This study found that most of the public works personnel in Duri Kosambi village were Muslims, had a senior high school level of education, and were of Betawi ethnicity. This was in line with the demographic data in the Cengkareng district, in that Duri Kosambi was the village with the greatest area, most of the residents were male, and the Islamic religion had the most believers (Badan Pusat Statistik Jakarta Barat, 2020). Among our respondents, more than ten percent were in the diabetes category. Socio-demographic factors capable of affecting dietary habits in patients with diabetes are the level of education and the type of family (Rondhianto *et al.*, 2024). Among the respondents of this study, the dominant right hand was used for working. In the adult population, a total of 90% of the residents preferred to use the right hand for manual tasks, whereas around 10% used the left hand (Zaccagni *et al.*, 2020). According to Agtuahene *et al.* (Agtuahene *et al.*, 2023), the dominant hand is generally around 10% stronger than the non-dominant hand. Many activities in daily life need a high level of exertion of the muscles of the hand and forearm (Hammed *et al.*, 2017). The frequent use of the dominant hand in daily living results in the muscles of the hand and forearm providing strength in gripping (Afaq *et* *al*., 2019).

The mean handgrip strength in this study was 33.1 ± 6.9 kg, which is relatively low if compared with the study results of Kurniawan *et al*. (Kurniawan *et al*., 2018). In healthy young Indonesian adults, the mean handgrip strength in males was 37.37 ± 8.29 kg, and the lower limit of muscle strength in Indonesian males was 20.79 kg. The handgrip strength results in both studies are still below those of males in other Southeast Asian countries, according to the study results of Leong *et al*. (Leong *et al*., 2016). These investigators found that the mean handgrip strength in Southeast Asian males aged 35-40 years was 40 kg (34-44 kg); for the age range of 41-50 years, the handgrip strength was 38 kg (33-44 kg), for the age range of 51-60 years it was 34 kg (30-40 kg), and for ages 61-70 years 30 kg (24-34 kg). This may have been caused by ethnic differences mediated by genetic differences that also affect individual muscle strength. The highest handgrip strength is found in the European and North American populations, whereas the lowest handgrip strength is found in African, South Asian, and Southeast Asian populations. These variations in muscle strength in various countries may also be partly caused by differences in socio-economic status (Leong *et al*., 2016).

According to Agtuahene *et al*. (Agtuahene *et al*., 2023), handgrip strength is a physiological variable influenced by several factors, such as age, sex, and body measurements. In contrast, according to Zaccagni *et al*. (Zaccagni *et al*., 2020), handgrip strength, apart from being affected by age, may also be influenced by physical activity, grip measurement, height, and body mass. The present study found a significant positive correlation between BMI and handgrip strength. According to Hammed *et al*., this may be caused by the higher percentage of skeletal muscle mass compared to the percentage of fat mass, thereby resulting in a higher handgrip strength. Our study's results are identical to those of Agtuahene *et al*. (Agtuahene *et al*., 2023), who found a significant positive correlation (r=0.290) of handgrip strength with BMI and height. This shows that taller individuals with higher BMI apparently have greater handgrip strength. Our study is also in line with the study of Krakauer in 2020, which showed a positive correlation between BMI and handgrip strength (Krakauer *et al*., 2020).

The study of Cooper *et al*. (Cooper *et al*., 2022) concluded that a high childhood BMI is associated with higher grip strength at age 46 years. This is because fat mass acts as a mechanical load that elicits an anabolic response that stimulates muscle growth and function. This anabolic response is usually greater in males than in females because of the higher testosterone concentration. However, it should also be noted that BMI does not differentiate between fat mass and lean mass as adipocyte indicators that may vary with sex. It should be noted that BMI is a measure of body fat that does not differentiate between weight changes because of an increase or decrease in muscle mass or body fat (Zaccagni *et al*., 2020). According to Jafar *et al*. (Jaafar *et al*., 2023), heavier individuals have a greater muscle mass, resulting in greater handgrip strength, than lighter individuals. In the study of Heidy *et al*. (Heidy *et al*., 2019), the investigators found a positive correlation between height and forearm length. The study by Sirajudeen *et al*. (Sirajudeen *et al*., 2012) found a positive correlation between hand length and handgrip strength. This shows that height affects the longer extremity or arm, thus approaching optimal muscle length that may result in greater grip strength. According to a prospective cohort study, handgrip strength in middle age appears to be associated with birth weight and the increase in height at puberty. Pubertal growth and handgrip strength possibly represent the development of muscle size and growth (Schrager *et al*., 2007).

Our study found no relationship between blood glucose concentration and handgrip strength. Our study agrees with the study of Giglio *et al*. (Giglio *et al*., 2018), which showed no significant relationship between muscle mass strength and blood glucose concentration. According to Giglio, this is because most respondents are individuals who routinely perform structured physical activity, even though they are in the light category. This is similar to our study respondents, who were public works personnel and who had performed physical activity such as street sweeping and cleaning storm drains. Glucose is the main fuel for muscle contraction, entering the muscle cells by diffusion through the GLUT4 glucose transporter, which, after muscle contraction, moves from its intracellular storage site to the plasma membrane and T-tubules (Richter *et al.*, 2013). Glucose metabolism has an influence on handgrip strength through various mechanisms, such as disorders of glucose metabolism, particularly glycogenolysis, that may result in the loss of muscle strength. Insulin resistance in hyperglycemia may cause muscle degradation because hyperglycemia causes low muscle strength through effects on skeletal muscle mitochondria. The lowering of muscle strength by hyperglycemia occurs through Krüppel-like factor 15, which regulates skeletal muscle lipid flux. Hyperglycemia also increases pro-inflammatory cytokines, which may increase the catabolism that plays a role in the further decrease in muscle mass and quality (Gamayanti *et al.*, 2023). The amount of carbohydrates also influences the glycemic response and post-prandial insulin level, impacting the supply of glycogen to the muscles (Safitri *et al.*,2020).

This study has a significant negative correlation between age and handgrip strength, which decreases with age (Manoharan *et al.*, 2015). Handgrip strength initially experiences an increase with increasing age, reaches its peak between the ages of 30 and 40 years, and decreases afterward (Zaccagni *et al.*, 2020). The age-related changes in skeletal muscle composition, particularly the accumulation of lipids in skeletal muscle fibers, play a role in the poor quality of the muscles and may result in metabolic abnormalities such as insulin resistance. Apart from changes in muscle quality, there is also a reduction in muscle mass that consistently occurs during aging. The increase in oxidative stress and chronic inflammation that commonly occurs in the aging process apparently also plays a role in the development of decreased muscle mass and strength (Mainous *et al.*, 2015). The decrease in muscle mass in the elderly corresponds to a 10% reduction in grip strength per decade, starting from the age of 40 years (Jaafar *et al.*, 2023). Skeletal muscle plays an important role in glucose metabolism and has a significant influence on insulin sensitivity. Increased insulin resistance in older adults may be closely associated with skeletal muscle aging. A reduction in GLUT4 expression as a result of a decrease in muscle volume causes a reduction in insulin sensitivity in aging skeletal muscle (Joo *et al.*, 2022). The results of this study showed a correlation of waist circumference and hip circumference with handgrip strength. This is in line with the study of Widjaja *et al.* (Widjaja *et al.*, 2018), who stated that there was a significant correlation of waist circumference and hip circumference with handgrip strength ($p=<0.001$, $r=0.302$; and $p=<0.001$, $r=0.296$) A greater waist circumference is associated with a greater handgrip strength in males (Hardy *et al.*, 2013).

In the multiple regression analysis of HGS, we removed the data on body weight because of the occurrence of multicollinearity between weight and BMI, with a correlation coefficient of more than 0.9, indicating an extremely strong relationship between these two variables. Conceptually, only one of the variables is used in multivariate analysis. The multiple regression analysis included age, height, BMI, waist circumference, and hip circumference, with HGS as the dependent variable in a stepwise manner. After three iterations, only height, BMI, and hip circumference played a role in predicting HGS by means of the regression formula, which resulted in $R^2=0.19$. This signifies that for known values of height, BMI, and hip circumference, we can predict the HGS value 19% more accurately than without knowledge of these data. For a clinical diagnosis, a minimum increase of 10% is needed. This study found that height, BMI, and hip circumference play a role in predicting handgrip strength through the regression formula, i.e., handgrip strength = - 36.98 + 0.48 x height + 0.79 x BMI – 0.29 x hip circumference. Handgrip strength and waist circumference are surrogate muscle strength and visceral adiposity markers, respectively (Nakanishi *et al.*, 2024). Waist circumference is also more sensitive in determining body fat distribution, particularly in the abdomen. Waist circumference correlates better with abdominal fat distribution than BMI (Rokhmah *et al.*, 2015). Waist circumference and hip circumference are associated with obesity, in which the fat content is higher, and the skeletal muscle and fascicular content is lower, thereby resulting in a lower contractile capacity of skeletal muscle (Afaq *et al*., 2019). The limitation of this study is that it did not evaluate other factors that may affect handgrip strength, such as nutrient intake. From the anthropometric measures of the hands and feet in this study, the causes and effects of the decrease in handgrip strength could not be determined because this study used a cross-sectional design.

Conclusion

Three factors may be used to estimate handgrip strength in PWP, namely height, BMI, and hip circumference, whereas blood glucose concentration is not correlated with handgrip strength in PWP. It is recommended to pay attention to height, BMI, and hip circumference, particularly in the acceptance criteria of PWP candidates, and to conduct further studies with consideration of other factors that affect handgrip strength, such as food intake and anthropometric features of the hands and arms.

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