IJRP.ORG
International Journal of Research Publications
ISSN: 2708-3578 (Online)

The correlation of body mass index and the handgrip strength in sedentary university students

Ahmad Riyono[a]*, Fauqi Amalia[b], Devi Arianti[a]

[a] ahmadriyono@vokasi.unair.ac.id

[a] *Department of Health, Faculty of Vocational Studies, Universitas Airlangga, Dharmawangsa Dalam Selatan No.28 – 30, Surabaya, Indonesia, 60286*

[b] *Faculty of Medicine, UIN Sunan Ampel Surabaya, Ir. H. Soekarno No. 682, Surabaya, Indonesia, 60237*

Abstract

Hand grip strength is commonly used to assess muscular strength and is increasingly recognized as an indicator of nutritional status. This study analyzes the correlation between body mass index (BMI) and hand grip strength (HGS) in sedentary university students. This cross-sectional, observational study included 54 undergraduate students from the Department of Health Universitas Airlangga, selected using a convenience sampling method. BMI was calculated using Quetelet's formula, while hand grip strength was assessed in the dominant hand using a Camry digital hand dynamometer, measured in kilograms. Statistical analyses were conducted using the SPSS Statistics program. Participants were categorized into four groups based on BMI classification concerning HGS. The mean BMI values were as follows: underweight (17.05±1.104), normal weight (20.58±1.426), overweight (23.74±0.350), and obese (28.58±3.868). The mean HGS values were: underweight (28.67±9.885), normal weight (26.76±5.796), overweight (32.23±9.085), and obese (34.95±9.659). The Spearman correlation test between BMI categories and HGS was not significant ($p > 0.05$). Males and females had mean BMI values of 24.33±4.765 kg/m² and 22.14±4.871 kg/m², respectively, with corresponding HGS values of 38.68±7.287 kg and 24.56±3.304 kg. The Spearman correlation test between BMI categories and gender was also not significant ($p > 0.05$). In conclusion, no significant correlation was found between BMI and HGS among sedentary university student.

Keywords: Handgrip; BMI; Good Health and Well-Being

1. Introduction

Nutritional status can influence muscle quality and muscle strength (Lad et al., 2013). Anthropometric measures, such as body mass index (BMI) and body weight, are used to evaluate nutritional status (Unhapipatpong et al., 2025). BMI is categorized into four groups according to the Asian-Pacific: underweight (<18.5 kg/m2), normal weight (18.5–22.9 kg/m2), overweight (23–24.9 kg/m2), and obese (≥25 kg/m2) (Lim et al., 2017). High BMI may affect muscle strength, muscle thickness, and fibre composition (Sung et al., 2022). Fat accumulation within skeletal muscle correlates with muscular weakness, diminished functionality, and an increased risk of mobility impairments (Delmonico et al., 2009). Being overweight or obese is associated with inadequate muscular strength and endurance (Comeras-Chueca et al., 2024). Overweight and obesity are frequently linked to reduced physical activity levels and increased sedentary behaviour (SB) in population research (Curran et al., 2023). Students' daily routines are characterized by sedentary activities, such as attending lectures, classes, seminars, and studying. Consequently, it is unsurprising that the prevalence of SB is significantly higher among university students compared to the global average (Edelmann et al., 2022).

Muscular strength is a more reliable indicator of adverse health outcomes than muscle mass. This is particularly evident in commonly used assessments such as handgrip strength (HGS), the chair stand test, and gait velocity (Cataltepe et al., 2023). The strength of upper limb muscles can be clinically evaluated by measuring HGS (Dhar & Purwar, 2023). HGS refers to the force generated during a grasping action involving deep and superficial upper extremity muscles (Dong et al., 2024). Grip strength is the force applied when grasping or manipulating objects with the thumb and fingers (Saldıran et al., 2025). Grip strength is an explanatory and predictive indicator of overall health outcomes, including general strength, disability, and mortality (Liu et al., 2024). Measuring muscle strength through grip strength assessment is simple and cost-effective (Çavdar et al., 2025). Handgrip strength has been associated with several anthropometric parameters, including weight, height, and BMI (Dhananjaya et al., 2017). HGS is assessed using a device known as a hand dynamometer, which quantifies the force exerted during hand grip (Hilal et al., 2025). To account for biological differences in handgrip strength within sex groups, poor muscle strength was determined using < 28 kg for men and <18 kg for women (Charatcharoenwitthaya et al., 2022).

Several studies have examined the association between BMI and HGS. However, research focusing specifically on sedentary university students remains limited. This study investigated the effects of BMI on grip strength, as assessed by a hand-held dynamometer (HHD), in sedentary university students.

2. Method

The study was a quantitative, cross-sectional, observational study conducted in the Department of Health, Faculty of Vocational Studies of Universitas Airlangga in February 2025. After providing written informed consent, 54 students aged 18 to 21, including 21 males and 33 females, were enrolled in the study. Participants with self-reported sedentary lifestyles were included in the study. They engaged in sitting activities during the learning process for approximately 6 to 8 hours per day. BMI was calculated by dividing weight in kilograms by the square of height in meters, using the formula: (Khanna et al., 2022).

$$BMI = \frac{weight\ (kg)}{height\ (m)^2}$$

The handgrip strength is measured easily by a hand-held dynamometer (HHD). Participants were requested to hold the digital hand dynamometer with the dominant hand, with the shoulder in a neutral position, the elbow bent at 90 degrees, and the wrist between 30° of dorsiflexion and applying maximum pressure for three seconds. The measurements were recorded in kilograms (Vaishya et al., 2024).

The baseline characteristics were presented using SPSS software, and the normality of all data was confirmed. Spearmen's correlation test interpreted the correlation of BMI with handgrip strength. The result of statistical analysis in a p-value of less than 0.05 at a 95% confidence interval was considered statistically significant.

3. Result and discussion

All This study included a nearly equal number of male and female participants (m=21, f=33). All participants were from the same institute, making the sample homogeneous. Hence, the sample was homogeneous. The demographic data of the participants has been described in Table 1.

Table 1
Descriptive statistics of general population characteristics and examination results (n = 54).

Demographic data	Min	P25	P50	Mean±sd	P75	Max
Age (years)#	18.00	19.00	20.00	19.66±1.046	20.00	23.00
Height (m)	1.46	1.54	1.61	1.61±0.076	1.67	1.750
Weight (kg)	36.00	51.00	58.50	60.50±15.027	70.25	103.00
BMI	15.38	19.25	22.25	23.14±4.861	26.09	40.23
HGS#	18.90	23.17	27.40	30.35±8.732	37.32	49.90

[1]Data are mean± standard deviation. #Non-normal data
[2]Abbreviation - BMI: body mass index, HGS: hand grip strength, sd: standard deviation, m: meter, kg: kilogram.

3.1 Correlation between the category of BMI and HGS

All subjects were divided into four groups based on BMI classification. Among the participants, 11.11% were classified as overweight, while 33.33% were categorized as obese according to the Asian BMI classification. In comparison, 42.59% were classified as normal weight, and 12.96% were underweight.
The mean HGS values indicated that the obese category had the highest grip strength, while the normal weight category had the lowest. Additionally, participants in the underweight category demonstrated higher HHD values than those in the normal weight category (Table 2).

Statistical analysis revealed no significant correlation between BMI and HGS across BMI categories ($p > 0.05$). However, muscular strength demonstrated a noticeable increase with a higher BMI (Pasdar et al., 2019). BMI has long been used as a screening and prognostic tool for obesity due to its convenience, ease of interpretation, and reproducibility. However, BMI has an inherent limitation as an accurate measure of adiposity, as it does not differentiate between fat and fat-free mass, including muscle, bone, fluids, and other body components (Dhar & Purwar, 2023). BMI does not differentiate between body fat and lean body mass and, therefore, is not a reliable predictor of body fat in older adults compared to younger and middle-aged individuals (An & Shi, 2015). Muscle strength in both obese and non-obese individuals is influenced by various factors beyond BMI or fat mass, which may impact performance metrics (Rolland et al., 2004). It is widely accepted that, regardless of age, individuals with higher body fat tend to have greater absolute maximum muscle strength than their non-obese counterparts. This suggests that increased adiposity acts as a persistent overload stress on antigravity muscles, leading to enhanced muscle size and strength (Tomlinson et al., 2016).

Table 2
Spearmen correlation test between the category of BMI values and HGS of participants

Category	Classification of BMI	N=54	BMI (kg/m^2)	HGS (kg)	r	p-value
Underweight	<18.5	7	17.05±1.104	28.67±9.885	0,60	0.148
Normal	18.5-22.9	23	20.58±1.426	26.76±5.796	- 0.17	0.422
Overweight	23-24.9	6	23.74±0.350	32.23.05±9.085	0.20	0.704
Obese	25-29.9	18	28.58±3.868	34.95±9.659	0.31	0.206

[1]Data are mean± standard deviation
[2]Abbreviation -BMI: body mass index, HGS: hand grip strength, m: meter, kg: kilogram. r: correlation of coefficient.

Obese individuals exhibit a reduced proportion of type I muscle fibers and an increased proportion of type IIb muscle fibers compared to lean individuals (Hickey et al., 1995; Tanner et al., 2002). Fast-twitch fibres can be classified into Type IIa, Type IIx, and Type IIb (Mo et al., 2023). Human fast-twitch muscle fibers generate high power in a short amount of time but are easily fatigued (Lievens et al., 2020). Body size is a crucial factor in muscle strength, with insufficient muscle strength being associated with lower body weight and vice versa (Hasan et al., 2016). Individuals with lower body mass frequently exhibit diminished strength (Rantanen et al., 2000). Being underweight is associated with reduced muscle mass and, therefore, reduced strength capabilities (An & Shi, 2015). Previous research has shown that lean subjects have more type I and less type IIb muscle fibers (Kern et al., 1999; Tanner et al., 2002). In humans, type I or slow-twitch fibers have slower contraction velocities and demonstrate considerable fatigue resistance (Plotkin et al., 2021). Men had significantly greater handgrip strength than women, and individuals classified as overweight or obese exhibited greater strength compared to their underweight counterparts (Doğan et al., 2023).

3.2 Gender-specific relationship between BMI and HGS

Of the 54 participants, males have a percentage of 38,88% and females 61,11%. The mean of HGS showed that males have higher hand grip strength than females. Statistical analysis showed that BMI and HGS did not have a significant correlation among the two genders ($p>0.05$) (Table 3).

Differences in muscle strength and body composition are evident between genders and ethnic groups. From early adulthood, women often possess 30 to 40% less physical strength than men (Lindle et al., 1997). A cross-sectional investigation identified no correlation between BMI category and muscle strength in a cohort of women (Apovian et al., 2002). The study indicated that boys exhibited superior performance to girls in terms of muscular strength, power, endurance, and overall physical fitness, which improved at a more rapid pace in boys, particularly during adolescence (Petrovics et al., 2021). Variations in muscle fibers types may elucidate the more significant force production in men than women. The study concluded that men and women possess comparable proportions of type I and type II fibers; however, type II fibers occupy a larger proportional area of muscle in males than in women (Nuzzo, 2022). This difference in muscle fiber composition may also explain why women demonstrate more excellent resistance to muscle fatigue than men during specific physical tasks (Hunter, 2016).

Table 3

Spearmen correlation test between gender-specific relationship between BMI and HGS

Demographic data	Variable	Mean±sd	p-value
Male	BMI	24.33±4.765	0.104
	HGS	38.68±7.287	
Female	BMI	22.14±4.871	0.340
	HGS	24.56±3.304	

[1]Data are mean± standard deviation

[2]Abbreviation -BMI: body mass index, HGS: hand grip strength

The unequal number of male and female participants as well as the unequal distribution of participants across BMI categories are limitations of our study. Consequently, for a more accurate assessment, experts should measure body fat percentage and fat-free mass separately. Furthermore, this study only included students between the ages of 18 and 25, and more research involving a wider range of age groups and the general public is advised. The results of this study are consistent with earlier investigations into the relationship between young adults' BMI and HHD.

4. Conclusion

There was no association between BMI and HGS, according to the study's findings. HGS values were lowest in the normal BMI category and highest in the obese BMI category. In addition, men's handgrip strength was greater than women's. To better understand the underlying mechanisms of this correlation, more research is necessary

5. Funding

None

6. Conflict of interest

The authors have declared the absence of financial support with commercial or personal interests, so no conflict of interest might inappropriately influence the study

7. Acknowledgement

The authors wish to thank the participants in the study

References

An, R., & Shi, Y. (2015). Body weight status and onset of functional limitations in U.S. middle-aged and older adults. *Disability and Health Journal*, *8*(3), 336–344. https://doi.org/10.1016/j.dhjo.2015.02.003

Apovian, C. M., Frey, C. M., Wood, G. C., Rogers, J. Z., Still, C. D., & Jensen, G. L. (2002). Body mass index and physical function in older women. *Obesity Research*, *10*(8), 740–747. https://doi.org/10.1038/oby.2002.101

Cataltepe, E., Ceker, E., Fadiloglu, A., & Varan, H. (2023). Evaluation of the relationship between different skeletal muscle mass indices and physical performance measures in older adults. *Clinical Nutrition ESPEN*, *58*, 474–475. https://doi.org/10.1016/j.clnesp.2023.09.147

Çavdar, S., Kocak, F. O. K., & Savas, S. (2025). The association of muscle weakness with functional disability in older patients with Diabetes mellitus: Measured by three different grip strength thresholds. *PLoS ONE*, *20*(1 January), 1–14. https://doi.org/10.1371/journal.pone.0317250

Charatcharoenwitthaya, P., Karaketklang, K., & Aekplakorn, W. (2022). Muscle strength, but not body mass index, is associated with mortality in patients with non-alcoholic fatty liver disease. *Journal of Cachexia, Sarcopenia and Muscle*, *13*(5), 2393–2404. https://doi.org/10.1002/jcsm.13001

Comeras-Chueca, C., Villalba-Heredia, L., Lozano-Berges, G., Matute-Llorente, Á., Marín-Puyalto, J., Vicente-Rodríguez, G., Casajús, J. A., & González-Agüero, A. (2024). High muscular fitness level may positively affect bone strength and body composition in children with overweight and obesity. *Archives of Osteoporosis*, *19*(1). https://doi.org/10.1007/s11657-024-01405-3

Curran, F., Davis, M. E., Murphy, K., Tersigni, N., King, A., Ngo, N., & O'Donoghue, G. (2023). Correlates of physical activity and sedentary behavior in adults living with overweight and obesity: A systematic review. *Obesity Reviews*, *24*(11). https://doi.org/10.1111/obr.13615

Delmonico, M. J., Harris, T. B., Visser, M., Park, S. W., Conroy, M. B., Velasquez-Mieyer, P., Boudreau, R., Manini, T. M., Nevitt, M., Newman, A. B., & Goodpaster, B. H. (2009). Longitudinal study of muscle strength, quality, and adipose tissue infiltration. *American Journal of Clinical Nutrition*, *90*(6), 1579–1585. https://doi.org/10.3945/ajcn.2009.28047

Dhananjaya, J. R., Veena, H. C., Mamatha, B. S., & Sudarshan, C. R. (2017). Comparative study of body mass index, hand grip strength, and handgrip endurance in healthy individuals. *National Journal of Physiology, Pharmacy and Pharmacology*, *7*(6), 594–598. https://doi.org/10.5455/njppp.2017.7.1030007022017

Dhar, D. K., & Purwar, B. (2023). Effect of Body Fat and BMI on Muscle Strength and Endurance in Young Adults: A Cross-sectional Study. *Journal of Clinical and Diagnostic Research*, *17*(10), 12–16. https://doi.org/10.7860/jcdr/2023/63970.18568

Doğan, G., Tokaç Er, N., Öztürk, M. E., Meriç, Ç. S., Yilmaz, H. Ö., & Yabanci Ayhan, N. (2023). Hand grip strength in young adults: association with obesity-related anthropometric variables. *Journal of Public Health (Germany)*, *6*. https://doi.org/10.1007/s10389-023-02060-7

Dong, Y., Cromer, P., Layman, D., Altvater, M., Dong, Y., & Zhu, H. (2024). The prevalence of small airways disease and association with handgrip strength in young Hispanic farmworkers. *BMC Pulmonary Medicine*, *24*(1). https://doi.org/10.1186/s12890-024-03382-2

Edelmann, D., Pfirrmann, D., Heller, S., Dietz, P., Reichel, J. L., Werner, A. M., Schäfer, M., Tibubos, A. N., Deci, N., Letzel, S., Simon, P., & Kalo, K. (2022). Physical Activity and Sedentary Behavior in University Students–The Role of Gender, Age, Field of Study, Targeted Degree, and Study Semester. *Frontiers in Public Health*, *10*(June), 1–12. https://doi.org/10.3389/fpubh.2022.821703

Hasan, N. A. K. A. K., Kamal, H. M., & Hussein, Z. A. (2016). Relation between body mass index percentile and muscle strength and endurance. *Egyptian Journal of Medical Human Genetics*, *17*(4), 367–372. https://doi.org/10.1016/j.ejmhg.2016.01.002

Hickey, M. S., Carey, J. O., Azevedo, J. L., Houmard, J. A., Pories, W. J., Israel, R. G., & Dohm, G. L. (1995). Skeletal muscle fiber composition is related to adiposity and in vitro glucose transport rate in humans. *American Journal of Physiology - Endocrinology and Metabolism*, *268*(3 31-3). https://doi.org/10.1152/ajpendo.1995.268.3.e453

Hilal, E., Usteki, F. M., Aksu, S., Bek, S., & Kutlu, G. (2025). The comparison of hand grip strength between healthy volunteers and individuals diagnosed with temporal lobe epilepsy. *Epilepsy and Behavior*, *163*(November 2024), 110201. https://doi.org/10.1016/j.yebeh.2024.110201

Hunter, S. K. (2016). The relevance of sex differences in performance fatigability. *Medicine and Science in Sports and Exercise*, *48*(11), 2247–2256. https://doi.org/10.1249/MSS.0000000000000928

Kern, P. A., Simsolo, R. B., & Fournier, M. (1999). Effect of weight loss on muscle fiber type, fiber size, capillarity, and succinate dehydrogenase activity in humans. *Journal of Clinical Endocrinology and Metabolism*, *84*(11), 4185–4190. https://doi.org/10.1210/jc.84.11.4185

Khanna, D., Peltzer, C., Kahar, P., & Parmar, M. S. (2022). Body Mass Index (BMI): A Screening Tool Analysis. *Cureus*, *14*(1994), 1–6. https://doi.org/10.7759/cureus.22119

Lad, U. P., Satyanarayana, P., Shisode-Lad, S., Siri, C. C., & Ratna Kumari, N. (2013). A study on the correlation between the Body Mass Index (BMI), the body fat percentage, the handgrip strength and the handgrip endurance in underweight, normal weight and overweight adolescents. *Journal of Clinical and Diagnostic Research*, *7*(1), 51–54. https://doi.org/10.7860/JCDR/2012/5026.2668

Lievens, E., Klass, M., Bex, T., & Derave, W. (2020). Muscle fiber typology substantially influences time to recover from highintensity exercise. *Journal of Applied Physiology*, *128*(3), 648–659. https://doi.org/10.1152/japplphysiol.00636.2019

Lim, J. U., Lee, J. H., Kim, J. S., Hwang, Y. Il, Kim, T. H., Lim, S. Y., Yoo, K. H., Jung, K. S., Kim, Y. K., & Rhee, C. K. (2017). Comparison of World Health Organization and Asia-Pacific body mass index classifications in COPD patients. *International Journal of COPD*, *12*, 2465–2475. https://doi.org/10.2147/COPD.S141295

Lindle, R. S., Metter, E. J., Lynch, N. A., Fleg, J. L., Fozard, J. L., Tobin, J., Roy, T. A., & Hurley, B. F. (1997). Age and gender comparisons of muscle strength in 654 women and men aged 20-93 yr. *Journal of Applied Physiology*, *83*(5), 1581–1587. https://doi.org/10.1152/jappl.1997.83.5.1581

Liu, Y. C., Huang, S. W., Adams, C. R., Lin, C. Y., Chen, Y. P., Kuo, Y. J., & Chuang, T. Y. (2024). Preoperative handgrip strength can predict early postoperative shoulder function in patients undergoing arthroscopic rotator cuff repair. *Journal of Orthopaedic Surgery and Research*, *19*(1), 1–9. https://doi.org/10.1186/s13018-024-04750-8

Mo, M., Zhang, Z., Wang, X., Shen, W., Zhang, L., & Lin, S. (2023). Molecular mechanisms underlying the impact of muscle fiber types on meat quality in livestock and poultry. *Frontiers in Veterinary Science*, *10*(2). https://doi.org/10.3389/fvets.2023.1284551

Nuzzo, J. L. (2022). Narrative Review of Sex Differences in Muscle. *The Journal of Stength and Conditioning Research*, *37*(2), 494–536. www.nsca.com

Pasdar, Y., Darbandi, M., Mirtaher, E., Rezaeian, S., Najafi, F., & Hamzeh, B. (2019). Associations between Muscle Strength with Different Measures of Obesity and Lipid Profiles in Men and Women: Results from RaNCD Cohort Study. *Clinical Nutrition Research*, *8*(2), 148. https://doi.org/10.7762/cnr.2019.8.2.148

Petrovics, P., Sandor, B., Palfi, A., Szekeres, Z., Atlasz, T., Toth, K., & Szabados, E. (2021). Association between obesity and overweight and cardiorespiratory and muscle performance in adolescents. *International Journal of Environmental Research and Public Health*, *18*(1), 1–10. https://doi.org/10.3390/ijerph18010134

Plotkin, D. L., Roberts, M. D., Haun, C. T., & Schoenfeld, B. J. (2021). Muscle fiber type transitions with exercise training: Shifting perspectives. *Sports*, *9*(9), 1–11. https://doi.org/10.3390/SPORTS9090127

Rantanen, T., Harris, T., Leveille, S. G., Visser, M., Foley, D., Masaki, K., & Guralnik, J. M. (2000). Muscle strength and body mass index as long-term predictors of mortality in initially healthy men. *Journals of Gerontology - Series A Biological Sciences and Medical Sciences*, *55*(3), 168–173. https://doi.org/10.1093/gerona/55.3.M168

Rolland, Y., Lauwers-Cances, V., Pahor, M., Fillaux, J., Grandjean, H., & Vellas, B. (2004). Muscle strength in obese elderly women: Effect of recreational physical activity in a cross-sectional study. *American Journal of Clinical Nutrition*, *79*(4), 552–557. https://doi.org/10.1093/ajcn/79.4.552

Saldıran, T. Ç., Schleip, R., Tanhan, A., Öztürk, Ö., & Kara, İ. (2025). Quantifying thenar muscle biomechanical properties: Sex-based variations and implications for grip strength. *Journal of Hand Therapy*, *xxxx*, 1–10. https://doi.org/10.1016/j.jht.2024.11.009

Sung, E. S., Han, A., Hinrichs, T., Vorgerd, M., & Platen, P. (2022). Impact of Body Mass Index on Muscle Strength, Thicknesses, and Fiber Composition in Young Women. *International Journal of Environmental Research and Public Health*, *19*(16). https://doi.org/10.3390/ijerph19169789

Tanner, C. J., Barakat, H. A., Lynis Dohm, G., Pories, W. J., MacDonald, K. G., Cunningham, P. R. G., Swanson, M. S., & Houmard, J. A. (2002). Muscle fiber type is associated with obesity and weight loss. *American Journal of Physiology - Endocrinology and Metabolism*, *282*(6 45-6), 1191–1196. https://doi.org/10.1152/ajpendo.00416.2001

Tomlinson, D. J., Erskine, R. M., Morse, C. I., Winwood, K., & Onambélé-Pearson, G. (2016). The impact of obesity on skeletal muscle strength and structure through adolescence to old age. *Biogerontology*, *17*(3), 467–483. https://doi.org/10.1007/s10522-015-9626-4

Unhapipatpong, C., Punsiha, T., Sessumpun, K., Chupisanyarote, K., & Julanon, N. (2025). Correlation between the Nutrition Alert Form (NAF) and the Mini Nutritional Assessment Short-Form (MNA-SF) in Hip Fracture Patients. *Biomedical Sciences and Clinical Medicine*, *64*(1), 12–22. https://doi.org/10.12982/BSCM.2025.06

Vaishya, R., Misra, A., Vaish, A., Ursino, N., & D'Ambrosi, R. (2024). Hand grip strength as a proposed new vital sign of health: a narrative review of evidences. *Journal of Health, Population and Nutrition*, *43*(1), 1–14. https://doi.org/10.1186/s41043-024-00500-y