CORRELATION BETWEEN HAND DOMINANCE, BODY MASS INDEX AND ISOMETRIC GRIP STRENGTH AMONG UNDERGRADUATE STUDENTS OF HUMAN KINETICS DEPARTMENT

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Abstract

This study aims to investigate the correlation between hand dominance, body mass index (BMI), and isometric grip strength among undergraduate students in the Human Kinetics Department, Ahmadu Bello University, Nigeria.A correlational research design was employed, with 25 undergraduate students aged 18 to 23 selected via purposive sampling. Data on hand dominance, BMI, and grip strength were collected using standardised tools and analysed using IBM SPSS version 20. The study found a weak positive correlation between BMI and both dominant and non-dominant hand grip strength. Additionally, a significant difference in grip strength was observed between dominant and non-dominant hands. However, a weak negative correlation was noted between age and grip strength. These findings suggest that higher BMI may be associated with stronger grip strength in both hands among undergraduate students. Moreover, hand dominance significantly influences grip strength. The study underscores the importance of considering these factors when assessing grip strength. However, limitations include the small sample size and the cross-sectional design, warranting caution in generalising the results. Future research should explore these relationships in larger and more diverse populations, employing longitudinal study designs to capture changes over time. Additionally, investigating additional anthropometric variables could provide a more comprehensive understanding of grip strength determinants.

KEYWORDS: Anthropometric variables, Musculoskeletal strength, Hand dominance, Undergraduate students, Correlational research

Introduction

A young adult is generally defined as a person ranging in age from their late teens or early twenties to their thirties(Arnett, 2023).The human hand is a crucial anatomical structure capable of a wide range of movements, both gross and skilled(Du Plessis, Djouani, &

Oosthuizen, 2021). The functions of the hand involve intricate coordination of motion, strength, dexterity, and motivation(Roby-Brami, Jarrasse, & Parry, 2021; Sánchez-Herrera-Baeza, Cano-de-la-Cuerda, Oña-Simbaña, Palacios-Ceña, Pérez-Corrales, Cuenca-Zaldivar, Gueita-Rodriguez, Balaguer-Bernaldo de Quirós, Jardón-Huete, & Cuesta-Gomez, 2020). Many daily activities require interaction with objects that need to be grasped by the hand(Bützer, Lambercy, Arata, & Gassert, 2021). The manipulative ability of the human hand relies on effective force and dexterity(Sobinov&Bensmaia, 2021). The hand serves as a specialised organ for gripping and sensation. This unique characteristic makes the hand an irreplaceable and subtle instrument for work and a sensory organ for humans(Bützer *et al.*, 2021; Du Plessis *et al.*, 2021; Roby-Brami *et al.*, 2021; Sobinov & Bensmaia, 2021).

The human hand is a sophisticated and highly functional structure, dedicated to the intricate tasks of manipulation(Sobinov&Bensmaia, 2021). It serves the crucial role of conveying sensory information to the brain about the temperature, shape, and texture of any object(McGlone, 2020; Raspopovic, Valle, &Petrini, 2021).The ability to execute a firm grip, coupled with the highly refined nervous control and sensitivity of the fingers, enables individuals to address the daily demands of life(Sobinov & Bensmaia, 2021; Soden, 2020).

The body mass index (BMI) is a commonly employed tool to assess overweight and obesity, relying on two anthropometric variables: weight measured in kilograms (kg) and height in meters (m)(Abdullahi, 2011; Abdullahi, Toriola, Goon, Paul, Igbokwe, & Suarau, 2017; Mohajan & Mohajan, 2023; Pawlak, Ręka, Olszewska, Warchulińska, &Piecewicz-Szczęsna, 2021; Piqueras, Ballester, Durá-Gil, Martinez-Hervas, Redón, & Real, 2021). Guidelines on reference values (cut-off points) for categorising an individual's weight condition, including classifications such as underweight, normal, and overweight exists (Abdullahi, Audu, &Ter Goon, 2020; Itani, Kreidieh, El Masri, Tannir, Chehade, & El Ghoch, 2020; Junior, Martins, Aznar, & Silva, 2023). While the World Health Organisation (WHO) acknowledges variations in normal range values for different populations, debates continue regarding their universality and compatibility(Bull, Al-Ansari, Biddle, Borodulin, Buman, Cardon, Carty, Chaput, Chastin, & Chou, 2020; WHO, 2021).Several studies (Chon, Shin, & Kim, 2020; Jones, Wewege, Hackett, Keogh, &Hagstrom, 2021; Kneavel, 2021; Lee, Kim, Paik, Jang, Chang, Baek, Lee, & Gong, 2012; Sternfeld, Ngo, Satariano, &Tager, 2002) have established correlations between strength and age, as well as gender.Across all age groups, girls consistently exhibit lower average values than boys in handgrip strength(Dağ&Erdoğan, 2020; Dooley, Kaster, Fitzgerald, Walch, Annandale, Ferrar, Lang, Smith, & Tomkinson, 2020; Essien, Amechi, Madu, Ede, Iyidobi, Anyaehie, Obadaseraye, Ogbonnaya, Ogbu, &Ngwangwa, 2023). This difference tends to amplify after puberty, reaching a point where, at the age of 18 years, boys demonstrate a mean handgrip strength that is 60% higher than that of girls(Ben Mansour, Kacem, Ishak, Grélot, &Ftaiti, 2021; Gillen, 2020; Lesinski, Schmelcher, Herz, Puta, Gabriel, Arampatzis, Laube, Büsch, &Granacher, 2020).Males exhibit significantly greater strength than females across all tested muscle groups(Abdullahi *et al.*, 2020; Ben Mansour *et al.*, 2021; Gillen, 2020; Lesinski *et al.*, 2020).

Handgrip strength serves as a crucial indicator for assessing physical fitness and nutritional status(Abdullahi *et al.*, 2020; Dağ&Erdoğan, 2020; Dooley *et al.*, 2020; Essien *et al.*, 2023). Widely recognised as one of the most reliable clinical measures of human strength, it provides valuable insights into an individual's muscular capabilities(Abdullahi *et al.*, 2020; Dağ&Erdoğan, 2020; Essien *et al.*, 2023). A sedentary lifestyle may contribute to diminished physical fitness and lower muscle strength(Lin, Chen, Ho, & Lee, 2020; Martins, Lopes, Diniz, &Guedes, 2021; Ramsey, Rojer, D'Andrea, Otten, Heymans, Trappenburg, Verlaan, Whittaker, Meskers, & Maier, 2021). Additionally, the accumulation of excess fat deposits over muscle fibers can further compromise muscle strength(Lin *et al.*, 2020; Martins *et al.*, 2021; Ramsey *et al.*, 2021).

The isometric test measuring handgrip strength serves as a reliable clinical measure for evaluating the physical fitness and nutritional status of an individual(Baptista, Zymbal, & Janz, 2022; Vaidya&Nariya, 2021; Valenzuela, Maffiuletti, Saner, Schütz, Rudin, Nef, & Urwyler, 2020). It stands out as the most commonly employed assessment method to gauge muscle strength in the upper extremities(Vaidya&Nariya, 2021).Handgrip strength serves as a valuable indicator of health status, providing insights into the incidence of disability, morbidity, and mortality within the adult population(Baptista *et al.*, 2022; Vaidya & Nariya, 2021; Valenzuela *et al.*, 2020).The power of handgrip is generated through forceful flexion of all finger joints, utilising the maximum voluntary force that a participant can exert under normal biomechanical conditions(Baptista *et al.*, 2022; Valenzuela *et al.*, 2020).Grip strength tends to be greater in the dominant hand among right-handed participants, whereas no statistically significant differences in strength between sides were observed for left-handed individuals(Bardo, Kivell, Town, Donati, Ballieux, Stamate, Edginton, & Forrester, 2021; Lijewski, Burdukiewicz, Pietraszewska, Andrzejewska, &Stachoń, 2021; Watterworth, Wakeely, Fitzgerald, & La Delfa, 2024). The handgrip strength of young, healthy adults has been found to have positive associations with anthropometric variables such as height, weight, BMI, hand length, hand width, and grip span.

The primary focus is on understanding the intricate connections between various factors related to handgrip strength in Undergraduate Students of Human Kinetics Department of Ahmadu Bello University, Zaria – Nigeria aged 18 to 23. One key aspect is exploring how body mass index (BMI) correlates with the maximum isometric handgrip strength. This involves assessing whether individuals with higher or lower BMI values exhibit differences in their handgrip strength. The study aims to provide a comprehensive analysis of maximal isometric handgrip strength in both dominant and non-dominant hands. This involves employing a handgrip dynamometer to measure the force applied during handgrip tests. The investigation extends to individuals who are both right- and left-handed, acknowledging potential differences in handgrip strength based on hand dominance. Furthermore, the study seeks to unveil the connection between hand dominance and isometric handgrip strength. By examining this relationship, researchers aim to understand whether individuals show variations in handgrip strength based on their dominant hand, contributing valuable insights into the biomechanics of hand function.

The study endeavors to unravel the intricate interplay between BMI, hand dominance, and age concerning maximal isometric handgrip strength in Undergraduate Students of Human Kinetics Department. Through detailed assessments and analyses, the research aims to contribute to the broader understanding of these factors and their implications for hand health and functionality.

Methodology

The study employed a correlational research design and a purposive sampling method, focusing on a study population of 25undergraduate students aged 18 to 23, characterised as normal and in good health. The research, conducted over a 3-month period, took place at Ahmadu Bello University, Zaria - Nigeria.

Inclusion criteria encompassed individuals aged 18 to 23, irrespective of gender, exhibiting good health, free of upper limb movement restrictions, and lacking a history of Rheumatoid arthritis, inflammatory joint disease, neurological disorders, or self-reported upper extremity injuries, and are involved in regular sporting activities. Exclusion criteria comprised smokers, alcohol consumers, pregnant women, those experiencing shoulder, arm, or hand pain at rest or during movement on most days of the month, and individuals with joint stiffness.

The study utilised various materials and tools for data collection, including a stethoscope (3M Littmann Classic III), sphygmomanometer (Calibra®), stadiometer (Seca 213 Portable), handheld handgrip dynamometer (JAMAR Hand Dynamometer), Edinburg handedness questionnaire sheets, and self-administered questionnaire sheets. Outcome measures focused on assessing handgrip strength in both dominant and non-dominant hands, along with Body Mass Index (BMI).

Procedure

Comprehensive preliminary assessments were conducted using a self-administered questionnaire to evaluate participants based on predefined inclusion and exclusion criteria. The assessment procedure was thoroughly explained to participants in clear and understandable language, and written informed consent was obtained prior to any measurements. Anthropometric measurements, including height and weight, were recorded, and hand dominance was determined using the Edinburg Handedness questionnaire during the initial investigation.

Body weight (kg) was measured using a portable weighing scale, with participants standing on the calibrated machine after removing heavy outer garments and shoes.

Height (m) was measured with an anthropometric rod, ensuring participants stood erect with shoes removed, feet together, and the vertical distance from the ground to the vertex of the participant was noted.

Body Mass Index (BMI) was calculated using the formula [(BMI = weight (kg) / height (m^2)]. Handgrip strength measurements were then obtained using a hand-held dynamometer, assessing grip strength in both dominant (DHgS) and non-dominant (non-DHgS) hands. Participants were positioned comfortably in a chair with specific arm and hand placements to maintain consistency.

The dynamometer, a standard adjustable digital handgrip dynamometer, was used for measurements. Three readings were taken for each hand, and the mean value was recorded. Participants were instructed to squeeze the dynamometer as hard as possible without body movement, and a series of precautions were taken to ensure proper positioning and accuracy. Three attempts were conducted for each hand, with a one-minute rest between attempts to mitigate fatigue. The mean of these three trials was considered as the final grip strength reading, and participants received no visual or verbal feedback during the process.

Statistical analysis

In the process of statistical analysis, IBM SPSS version 20 was utilised to examine and interpret the collected data. Descriptive statistics were employed as a means of summarising key aspects of the study's participants, including their age, sex, and various outcome measures. This method allowed for a clear and concise presentation of the essential demographic and measured variables. To ensure the data's conformity to a normal distribution, the Shapiro-Wilk test was performed. This test is instrumental in assessing whether the data deviates significantly from a normal distribution. It provided insights into the distribution characteristics of the variables under consideration, aiding in the appropriate application of subsequent statistical tests.

In exploring the interrelationships within the dataset, particularly between age, Body Mass Index (BMI), hand dominance, and handgrip strength, the Pearson correlation coefficient test was applied. This statistical measure helped quantify the strength and direction of linear associations between pairs of variables. By determining correlation coefficients, the study aimed to uncover any significant connections or dependencies among these crucial elements. The chosen level of significance for all statistical tests was set at $p \leq 0.05$. This standard significance level ensures a stringent criterion for considering results as statistically meaningful, allowing researchers to draw reliable conclusions based on the observed data patterns.

Results

The study encompassed a cohort of 25undergraduate students aged 18 to 23 (Min= 18, Max = 23, Mean = 20.4 and SD = 1.493) representing both genders. The gender distribution indicated that 20% (5) were males, while 80% (20) were females. Table 1 provides a descriptive statistical analysis for key parameters, including Age, Body Mass Index (BMI), Dominant handgrip strength (DHgS), and non-Dominant handgrip strength (non-DHgS). This table also elucidates the handgrip strength values in DHgS and non-DHgS within the study population. The calculated mean ± Standard Deviation (SD) for DHgS in the study cohort was 1.231 ± 1.151, and for non-DHgS, it was 1.699 ± 1.172. Notably, a statistically significant difference was observed in handgrip strength between DHgS and non-DHgS.

Table 3 illustrates a positive correlation between BMI and DHgS, with a correlation coefficient of 0.198. Similarly, it demonstrates a positive correlation between BMI and non-DHgS, albeit with a slightly lower correlation coefficient of 0.118.These findings provide a quantitative overview of the study's participant demographics and key variables, shedding light on the relationships observed within the dataset.

Table 1: Summary of descriptive statistical analysis for age, BMI, DHgS and non-DHgS

	N	MEAN	SD
Age	25	20.40	1.493
BMI	25	21.43	4.58
Grip	25	25.33	5.20
Grip 2	25	23.96	5.015

N = Number, SD = Standard Deviation

Table 2: shows BMI distribution among participants

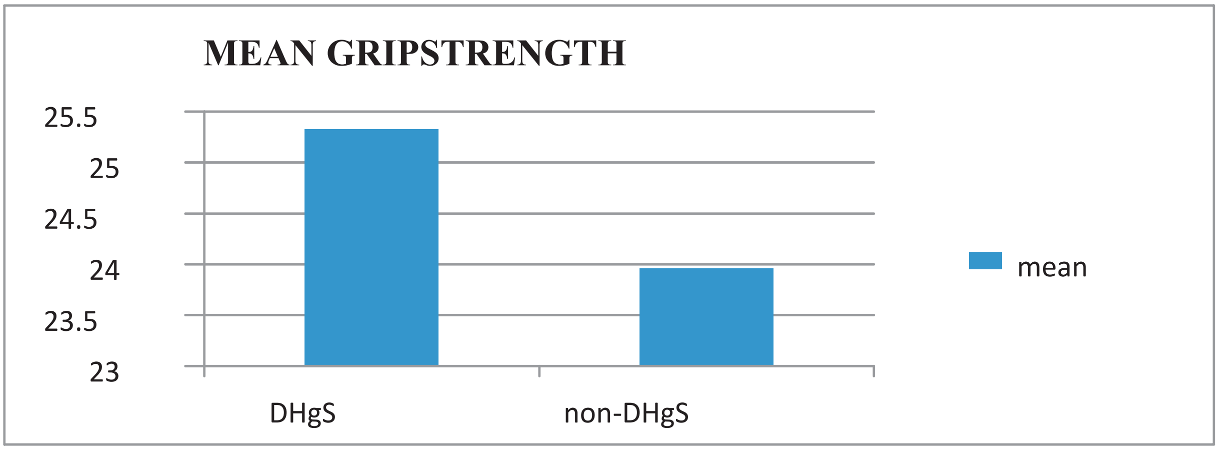
	BMI	N
Underweight	<18.5	4
Normal	18.5-24.9	17
Overweight	25.0-29.9	3
Obesity **category**1	30.0-34.9	1
Category 2	35.0-39.9	0
Category 3	-	0

N = Number

Table 3: Correlational values between BMI and DHgS, BMI and Non-DHgS, Age and Grip strength (N = 25)

Variables	Pearson corelation	Sig.(2-tailed)
BMI vsDHgS	1	0.167
	0.198	
BMI vsNon-DHgS	1	0.414
	0.118	
Agevs Grip strength	1	0.310
	-0.148	

Graph 1.Mean comparisons of DHgS and non-DHgS



Discussion

The primary objective of this study was to investigate the intricate relationships among age, Body Mass Index (BMI), hand dominance, and handgrip strength in a cohort of normal Undergraduate Students of Human Kinetics Department. Handgrip strength has historically been regarded as a potential indicator of an individual's overall physical strength, as evidenced by correlations observed in various populations in previous studies(Abdullahi *et al.*, 2020; Bardo *et al.*, 2021; Dooley *et al.*, 2020; Halaweh, 2020; Kunutsor, Isiozor, Khan, & Laukkanen, 2021; McGrath, Johnson, Klawitter, Mahoney, Trautman, Carlson, Rockstad, & Hackney, 2020; Watterworth *et al.*, 2024; Zaccagni, Toselli, Bramanti, Gualdi-Russo, Mongillo, &Rinaldo, 2020).

This investigation aligns with existing literature, establishing significant correlations between age, BMI, hand dominance, and handgrip strength(Abdullahi *et al.*, 2020; Bardo *et al.*, 2021; Dooley *et al.*, 2020; Halaweh, 2020; Kunutsor *et al.*, 2021; McGrath *et al.*, 2020; Watterworth *et al.*, 2024; Zaccagni *et al.*, 2020). While handedness is genetically determined, the study underscores that handgrip strength is substantially influenced by an individual's nutritional status, positioning it as a functional index of nutritional health(Mendoza-Garcés, Velázquez-Alva, Cabrer-Rosales, Arrieta-Cruz, Gutiérrez-Juárez, &Irigoyen-Camacho, 2021; Palacio-Agüero, Díaz-Torrente, &Quintiliano Scarpelli Dourado, 2020; Pavlović, Petrović, Kozić, &Ćeho, 2021; Pigłowska, Guligowska, &Kostka, 2020). Moreover, the study reaffirms the widely accepted notion that the dominant hand tends to be approximately 10% stronger than the non-dominant hand, as per established norms and previous research findings(Dağ&Erdoğan, 2020; Kunutsor *et al.*, 2021; Zaccagni *et al.*, 2020).

Earlier studies (Keogh, Weber, & Dalton, 2003; Koley & Kaur, 2011; Zaccagni *et al.*, 2020)have demonstrated robust correlations between handgrip strength and various anthropometric characteristics such as height, weight, and BMI. In this study, a noteworthy weak positive correlation emerged between BMI and both dominant handgrip strength (DHgS) and non-dominant handgrip strength (non-DHgS). The negative correlation between age and handgrip strength can be explained by the natural decline in musculoskeletal strength associated with the aging process.

Furthermore, the study's confirmation of the gender-based disparity in handgrip strength, with males exhibiting greater strength than females, aligns with established patterns observed in previous research. This investigation also provides empirical support for the higher mean handgrip strength in males. Notably, the study adds insights into the relationship between height and handgrip strength, suggesting that increased height contributes to longer arms, thereby enhancing the lever arm for more efficient force generation (Lee *et al.*, 2012). Although the study explored the correlation of BMI with handgrip strength, specific examinations of the individual relationships of height and weight with dominant and non-dominant handgrip strength were not conducted, citing age-related changes in body composition as a rationale.

This study significantly contributes to the existing body of knowledge surrounding the complex interplay between age, BMI, hand dominance, and handgrip strength in normal Undergraduate Students of Human Kinetics Department. By shedding light on these relationships, the study enhances our understanding of the multifaceted factors influencing physical strength and lays the groundwork for future research endeavors.

Conclusion

In the present study, the analysis reveals noteworthy findings regarding the correlation between grip strength, age, BMI, and hand dominance. Firstly, a weak negative correlation was observed between grip strength and age, suggesting that as individuals age, there is a tendency for grip strength to decrease, albeit moderately. This finding aligns with the commonly understood notion of a decline in muscle strength with advancing age.

Conversely, the study identified a weak positive correlation between BMI and both Dominant handgrip strength (DHgS) and non-Dominant handgrip strength (non-DHgS). This indicates that individuals with higher body mass indexes tend to exhibit slightly stronger grip strengths in both hands. This correlation sheds light on the potential influence of body composition on handgrip strength. Moreover, the study emphasises the role of hand dominance in handgrip strength. The statistical analysis indicates a significant difference in handgrip strength between the dominant and non-dominant hands. This underscores the importance of considering hand dominance when assessing grip strength, as it can impact the overall findings and interpretations.

Despite these insights, the study has its limitations. The utilisation of a small group cross-sectional design within a single institution may restrict the generalisability of the results. Additionally, the study did not explore correlations with other anthropometric variables, leaving potential relationships unexamined. To enhance the validity and applicability of future research, recommendations include employing larger sample sizes, opting for longitudinal study designs to capture changes over time, and expanding the scope to encompass various age groups. Furthermore, investigating additional anthropometric variables related to hand and body composition would contribute to a more comprehensive understanding of the factors influencing grip strength.

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