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Association Of Handgrip Strength, Body Mass Index, Waist Circumference And Depression Scale Among Adults: A Hospital Based Cross-Sectional Observational Study

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Abstract

In the northeastern region of India, particularly, there has been limited research on the connection between handgrip strength, body mass index (BMI), and depression. The current study aimed to investigate whether obesity in adult women (aged 20 to 80) influenced the relationship between handgrip strength and the risk of depression. This research was conducted at Kolkata's Peerless Hospital from February 2022 to March 2023, involving a cross-sectional observational study with a total of 458 participants, both male and female, aged 18 to 80. Ethical clearance for the study was obtained from the Ethics Committee of Peerless Hospital and B K Roy Research Center, located at 360 Pancha Sayar Rd, Sahid Smirity Colony, Pancha Sayar, Kolkata, West Bengal 700094 (PHH&RCLCREC/ 4020/2023). The study adhered to the ethical guidelines established by the institution's research committee and followed the principles outlined in the 1964 Helsinki Declaration and its subsequent revisions to ensure consistent ethical standards in all procedures involving human participants. Prior to commencing the study, informed written consent was obtained from all participants. Older women with thyroid dysfunction, or hormone replacement therapy, amenorrhea, those taking vitamin D supplements and individuals with physical or mental challenges, and those who were generally uncooperative were excluded from the study. The results of the present study demonstrated a statistically significant association between depression and handgrip strength, as indicated by the Chi-Square test. Handgrip strength also displayed a significant negative correlation with BMI. Waist circumference (WC) showed a significant association with handgrip strength, with an odds ratio (OR) of 2.66. Furthermore, there was a significant negative correlation

between WC and handgrip strength. When considering body fat percentage, the OR for handgrip strength was 2.92, and a significant association was observed between handgrip strength and body fat percentage.

Keywords: Hand-grip strength, obesity, depression, waist -circumference

1. Introduction

Depression is a significant public health concern, affecting an estimated 350 million individuals globally (McDowell *et al*., 2018). Research by Kang *et al*. (2018) highlights that depression not only impairs cognitive function and quality of life but also elevates the likelihood of developing chronic coexisting conditions such as diabetes, cardiovascular disease, and arthritis. This viewpoint is shared by Seo and Je, Vallerand et al. (2018), and Xuan *et al*. (2018). Furthermore, depression increases the risk of suicide, as noted by Chapman and Perry in 2008. Consequently, the prevention and treatment of depression are of paramount importance. Previous data-driven studies have explored the connection between handgrip strength and depression, revealing that individuals with weaker grip strength are at a higher risk of experiencing depression (Ashdown-Franks *et al*., 2019).

Key Symptoms for depression
Persistent sadness or low mood; Loss of interest or pleasure; Fatigue or low energy.
To meet the diagnostic criteria for depression, an individual must experience at least one of the key symptoms listed above on most days and for most of the time, for a minimum duration of two weeks. If any of these key symptoms are present, the following associated symptoms should also be assessed:

Associated Symptoms
Disturbed sleep, poor concentration or indecisiveness, low self-confidence, poor or increased appetite, suicidal thoughts or acts, agitation or slowing of movements

Guilt or self-blame
The severity of depression is determined by the number of these ten symptoms that an individual experiences, and the management approach is tailored accordingly:
Not depressed: Fewer than four symptoms
Mild depression: Four symptoms
Moderate depression: Five to six symptoms
Severe depression: Seven or more symptoms, with or without psychotic symptoms
Furthermore, it's important to note that these symptoms should persist for a month or longer, and each symptom should be present for most of every day to meet the diagnostic criteria for depression according to ICD-10.

2. Methodology:

- **Study design:** A cross-sectional descriptive study was conducted.
- **Study Area:** Peerless multispecialty hospitals
- **Sample size**: More than 1000 to be collected.
- **Ethical Clearance**: Obtained from ethics committee of Peerless Hospital and research centre limited **(PHH&RCLCREC/4020/2023)**
- **Participants:** Hospitalized adult population as defined by WHO (19-60 years of age)
- **Inclusion criterion:** Hospitalized adults (Male & Female) (19-60 years of age) having hypertension.
- **Exclusion criterion:** Adults suffering from severe cognitive impairment or physically unfit or unable to stand up or too fatigued to meet new persons or unwilling to participate in the survey**.**
- **Tools to be used**: Activex body composition analyser, Hand grip dynamometer, skin fold caliper, measuring tape, digital blood pressure machine, pulse oxymeter, weighing scales
- **Questionnaire:** Pretested questionnaire to be used.
- **Assessment of inflammatory markers –** Blood reports of CRP and ESR to be obtained from hospital records for the hospitalized participants.
- **Anthropometric measurements –** Waist and Hip ratio, Waist circumference to be measured.

- **MUST (Malnutrition Universal Screening Tool to be assessed)**
- **Statistical analysis-** All the statistical analysis to be done in SPSS software, version 19.0 (statistical package for the social sciences INC, Chicago, IL,USA)

Trained interviewers collected patient data related to their clinical history, which included information about any history of stroke, use of anti-hypertensive medications, and their habits. Blood reports were retrieved from the hospital's database for reference.
To ensure accuracy, qualified examiners measured the systolic and diastolic blood pressures of the right arm after the patient had rested in a seated position for at least five minutes. They used a blood pressure measuring device (HEM-907; Omron, Kyoto, Japan). Hypertension was defined according to the World Health Organization (WHO) criteria, with a threshold of 140 mmHg for systolic blood pressure and/or 90 mmHg for diastolic blood pressure (Unger *et al*.,2020). Diastolic hypertension was identified when the diastolic blood pressure was less than 90 mmHg and the systolic blood pressure was greater than 140 mmHg.
During the assessment, the elbow was flexed to a 90-degree angle, the forearm was positioned neutrally, the wrist was extended between 0 and 15 degrees, and the ulnar deviation ranged from 0 to 15 degrees for the arm under examination. If needed for achieving a maximal contraction, the fingers were flexed. The examiner verbally instructed the patient with commands such as "Squeeze! Harder! Harder! Relax!" To calculate the average hand grip strength (HGS), three consecutive trials were conducted, with a one-minute break between each trial to ensure accuracy and consistency in the measurements.

3. Results

Data Collection and Anthropometric measurements

Body weight and height measurements were taken with patients wearing only light clothing and no shoes, using an automatic body composition analyzer (Activex, Australia, Savvy fat scale, employing dual-frequency BIA technology). Body mass index (BMI) was calculated as the patient's weight in kilograms divided by the square of their height in meters. It is widely recognized that certain medical conditions, such as osteoporosis, osteoarthritis, cancer, diabetes, and cardiovascular disease, are linked to an individual's body composition. Assessing changes in body composition can serve as an effective means of evaluating the impact of nutritional treatments and monitoring alterations brought about by conditions such as growth or illness. Situations such as wasting and stunting can indicate changes in body composition when nutrient intake is inadequate, while overeating can lead to obesity [Kuriyan *et al*., 2018].
The grip strength of the responders was evaluated using a Camry® (Model EH 101) Hand Dynamometer (Huang *et al*., 2022). Each participant received an explanation of the process and a demonstration of the method based on the American Society of Hand Therapists' standard operating procedure. Participants sat in chairs with straight backs and flat feet on the ground. During the assessment, the elbow was flexed to a 90-degree angle, the forearm was positioned neutrally, the wrist was extended between 0 and 15 degrees, and the ulnar deviation ranged from 0 to 15 degrees for the arm under examination. If needed for achieving a maximal contraction, the fingers were flexed. The examiner verbally instructed the patient with commands such as "Squeeze! Harder! Harder! Relax!" To calculate the average hand grip strength (HGS), three consecutive trials were conducted, with a one-minute break between each trial to ensure accuracy and consistency in the measurements. The hand dynamometer measures grip strength and could help to make it stronger. The amount of gripping force one has can be precisely measured using a strain gauge sensor on the dynamometer. Up to 198 pounds or 90 kg, it may measure in increments of 0.20 pounds or 0.10 kg. It must initially be turned on, a profile selected, and the handle pressed for five seconds before it can be used. The highest grip value and a status bar will then show up on the screen. (poor, average, or firm grip)(Robert Wood, 2012). Analysis of values was done based on machine interpretation of Weak, Normal and Strong. And as no cases reported Strong in dynamometer but reported figures which was below weak zone was considered as poor.

Waist circumference - The simple numerator in the WHR (Waist Hip Ratio) equation is waist circumference. It offers the benefits of being simpler to assess and avoiding taking the hips into account, which should have no biologically logical connection to diabetes, hypertension, or atherosclerosis because they also include bone and skeletal muscle. The recommended thresholds for an elevated health risk are waist circumferences exceeding 102 cm (or greater than 40 inches) for men and 88 cm (or exceeding 35 inches) for women [Steven McGee, 2018].

Waist Hip ratio – According to the WHO STEPS (STEP wise Approach to Surveillance) guideline from 2008, the measurement should be taken approximately at the midpoint between the top of the iliac crest and the lower

edge of the last discernible rib [WHO, 2008b]. However, in accordance with the protocol outlined by the US National Institutes of Health (NIH) as detailed in the NIH Practical Guide to Obesity (NHLBI Obesity Education Initiative, 2000) and the procedure employed in the US National Health and Nutrition Examination Survey (NHANES) III (Westat Inc, 1998), the waist measurement should be taken at the top of the iliac crest [WHO, 2008].
The ICD-10 (International Classification of Diseases, 10th edition) utilizes a standardized set of criteria to diagnose depression, consisting of ten key depressive symptoms. These criteria are as follows:

Table 1- Distribution of hand grip strength (HGS) according to their BMI, waist circumference (WC), body fat percentage (BF%), waist hip ratio (WHR) (N=458)

Parameters	HGS (kg) (N=458)				Statistical Analysis					
					Male(N=222)			Female (N=236)		
	Normal (machine interpretation) N (%)	Weak (machine interpretation) N (%)	Poor (machine interpretation) N (%)	Normal (machine interpretation) N(%)	HGS (kg) Median (IQR)	Kruskal Wallis-test (p)	Spearman Correlation (p)	HGS (kg) Median (IQR)	Kruskal Wallis-test (p)	Spearman Correlation (p)
Age 18-45 45-60 60-80	28(25.0) 26(17.23) 23(11.86)	82(72.32) 119(78.81) 156(80.41)	3(2.68) 6(3.97) 13(6.70)	113(100) 151(100) 194(100)	13 (6) 14 (4) 13 (4)	**26.836 (0.00)**	**0.348 (0.00)**	16 (2.75) 14 (4) 13 (3.75)	3.216 (0.20)	0.232 (0.07)
BMI Underweight Normal Overweight Obesity I Obesity II Obesity III	4(12.5) 18(11.84) 26(18.84) 23(19.49) 5(35.71) 1(25.0)	18(56.25) 126(82.89) 109(78.99) 92(77.97) 9(64.28) 3(75.0)	10(31.25) 8(5.26) 3(2.17) 3(2.54) 0(0.0) 0(0.0)	32(100) 152(100) 138(100) 118(100) 14(100) 4(100)	13 (1) 13 (6.75) 14 (4) 13 (4) 14 (5) 0 (0)	**18.391 (0.00)**	**0.266 (0.00)**	16 (3.75) 13.5 (7.75) 14.3 (2.75) 14 (4) 11 (11) 13 (1)	1.765 (0.414)	-0.173 (0.186)
WC (cm) Male - <90, Female - <80 Male - >90, Female - >80	0(16.82) 77(16.92)	1(33.33) 356(78.24)	2(66.67) 22(4.84)	3(100) 455(100)	00 (0) 13 (4)	**9.032 (0.011)**	**-0.190 (0.005)**	0 (0) 14 (4)	0.454 (0.797)	-0.086 (0.515)
BF (%) Lean Ideal Average Above Average	20(9.39) 27(20.30) 17(22.37) 13(36.11)	172(80.75) 105(78.95) 58(76.31) 23(63.89)	21(9.86) 1(0.75) 1(1.32) 0(0.00)	213(100) 133(100) 76(100) 36(100)	13 (5) 14.5 (5) 13 (2.25) 13 (4)	**8.882 (0.012)**	**-0.192 (0.004)**	14 (4) 14 (3) 14 (4) 11 (11)	1.587 (0.452)	-0.091 (0.490)

** The result is significant $p<0.05$, mentioned in bold.

4. Discussion

In the present study, among a total of 458 respondents, the distribution of hand grip strength (HGS) was as follows: 16.81% had normal HGS, 78.16% had weak HGS, and 5.03% had very weak or poor HGS. Given the skewed nature of the dataset, measures of central tendency, specifically the Median and Interquartile Range (IQR), were used. Regarding the relationship between depression scale and HGS, a significant statistical association was observed (Chi-square value: 41.75, p=0.01). The Odds Ratio (OR) was calculated as 0.015, with a 95% Confidence Interval (CI) ranging from 0.003 to 0.064. This suggests that depression scale scores are associated with hand grip strength, with lower HGS being linked to higher depression scores. According to the ICD-10 depression scale from the World Health Organization (WHO), 69% of respondents were free from any depression, 1.96% suffered from moderate/severe depression, and 29.04% were in mild depression.
For male respondents, a significant statistical association was observed between BMI and HGS, as indicated by both the Kruskal-Wallis test and the Chi-square test (p=0.00). There was also a significant negative correlation (Spearman's Correlation) between BMI and HGS among male respondents (-0.266, p=0.0), indicating that lower BMI values were associated with higher hand grip strength. The Odds Ratio (OR) for BMI was 1.84, with a 95% CI of 1.08-3.15. However, for female respondents, there was a negative correlation between BMI and HGS, but it was not statistically significant (p=0.186).When considering waist circumference (WC) and HGS, a statistically significant association was found (Chi-square=9.04, p=0.02), and the Odds Ratio (OR) was calculated as 2.66, with a 95% CI of 0.14-47.74. Among male respondents, there was a significant statistical association between HGS and WC according to the Kruskal-Wallis Test (p=0.01), and a significant negative correlation was also observed (p=0.005).

Regarding body fat (BF), a significant statistical association was observed between BF and HGS (Chi-square value: 42.29, p=0.00), with an Odds Ratio (OR) of 2.92 and a 95% CI of 1.69-5.05. Among male respondents, a significant negative correlation was found (p=0.0) between BF and HGS, and the Kruskal-Wallis test also indicated a significant association (p=0.0). These findings suggest that there is a meaningful relationship between body fat levels and hand grip strength, particularly among male participant.
Depression has a profound impact on overall health, and our current study reinforces this observation. We have found significant statistical evidence of a link between depression and hand grip strength (HGS), as determined by the Chi-Square test. However, further in-depth research is needed in this area to gain a clearer understanding of the prognosis associated with this relationship. When examining the body mass index (BMI) or nutritional status of the participants, our findings reveal a noteworthy negative correlation between HGS and BMI. Additionally, there is a substantial association between waist circumference (WC) and HGS, with an odds ratio (OR) of 2.66. Furthermore, a significant negative correlation exists between WC and HGS. As for body fat percentage, the odds ratio for its association with HGS stands at 2.92. In summary, our study underscores significant associations between HGS and various factors related to physical health.

5. Conclusion

Indeed, the findings of the present study highlight the significant relationship between depression and hand grip strength (HGS), shedding light on how depression can impact overall health. The study also reveals a noteworthy negative correlation between HGS and BMI, as well as a significant association with body fat percentage. It is worth considering that depression can be viewed as one of the risk factors for adiposity, which aligns with the perspective of the Centers for Disease Control and Prevention (CDC). Adiposity, or excess body fat, has been associated with the release of various inflammatory substances from adipose tissue. These substances include pro- and anti-inflammatory adipokines like resistin, leptin, and adiponectin, as well as cytokines and chemokines such as TNF-α, IL-6, and MCP-1. These molecules are produced and released by adipose tissue and play a role in inflammation within the body. This inflammation, in turn, may have a significant impact on muscle health, potentially contributing to sarcopenia, which is characterized by a decrease in muscle mass. The relationship between depression, adiposity, inflammation, and its effects on muscle health underscores the complex interplay between mental and physical well-being. It's important to note that further research is required to gain a deeper understanding of the long-term effects of depression in association with hand grip strength and to explore the potential mechanisms underlying these relationships.

Future Scope
Future research in the domain of the correlation between handgrip strength, body mass index (BMI), waist circumference, and depression scale in adults holds great promise and has the potential to offer significant contributions to multiple disciplines, including public health, psychology, and medicine. Here are some prospective avenues for future investigation in this field:

1. **"Longitudinal Research:** While cross-sectional studies offer a snapshot of data at a specific moment, future investigations could encompass longitudinal studies that track participants over an extended duration. This approach would enable researchers to delve into causality and the evolving connections among these factors. For instance, it could involve examining how alterations in handgrip strength, BMI, or waist circumference over time are linked to shifts in depression scores."Causal Relationships: Conducting interventional studies or randomized controlled trials (RCTs) to determine if interventions aimed at improving handgrip strength or reducing BMI and waist circumference can have a positive impact on reducing depression symptoms. This would provide more concrete evidence of causality.

Gender and Age Differences: Examining whether the association between these variables differs by gender and age groups. For instance, do the relationships hold true for both men and women? Are there age-specific patterns?

Psychological Mechanisms: Delving into the psychological mechanisms underlying these associations. Investigate how improvements in physical strength or changes in body composition may affect self-esteem, body image,

Conflict of Interest: The authors declare no conflicts of interest in the publication of this paper.

Author's Contribution: Bijoya Bhattacharjee conceived the idea and conducted the entire cross-sectional observational study. Dr. Rupali Dhara Mitra provided extensive manuscript editing. Dr. Subhrajyoti Bhowmick contributed to the medical conceptualization of the study, facilitated administrative clearances, and obtained ethical approval. Ms. Sudeshna Maitra Nag and Ankita Bhattacharjee assisted in data collection at Peerless Hospital. Ms. Sudrita, Ms. Khusboo, Ms. Shreyashee, Ms. Juhi, Ms. Shrestha, Ms. Asmita, and Mr. Ali were involved in data validation, data quality assurance, and statistical analysis.

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