

BODY FAT AND HAND GRIP STRENGTH AMONG PATIENTS WITH TYPE 2 DIABETES MELLITUS

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Abstract

Background: Type 2 Diabetes Mellitus is a chronic disease that is increasingly affecting people in the world. According to the World Health Organization (WHO), India has over 70 million people living with type 2 Diabetes, making it one of the countries most affected by this disease. However, there is a scarcity of research on how body composition and muscle strength are interconnected in patients with Type 2 Diabetes Mellitus. **Objective:** We investigated the association between body fat, hand grip strength and metabolic health in Type 2 Diabetes Mellitus patients. **Methods:** A systematic review was conducted using databases such as PubMed, Google Scholar and Research Gate, encompassing studies from 2000 to 2024. The inclusion criteria covered studies that assessed Hand grip strength (HGS) and body fat in Type 2 Diabetes Mellitus patients and their metabolic implications. **Results:** The review indicates a significant inverse relationship between body fat, particularly Visceral fat and Hand grip strength, affecting both muscle strength and metabolic health. Higher body fat percentages are linked to lower HGS and poorer Glycemic control. **Conclusion:** The findings highlight the importance of reducing body fat and improving muscle strength for better management of Type 2 Diabetes Mellitus.

INTRODUCTION

Metabolic syndrome (MS) is a complicated illness characterized by a network of interconnected physiological, biochemical, clinical, and metabolic variables that raise the risk of cardiovascular disease, type 2 diabetes, and all-cause mortality.¹ Defective blood glucose regulation is a condition known as Diabetes^{2,3}. About 90% of Diabetes patients

are type 2 Diabetes Mellitus (T2DM), making it the most common form of Diabetes in the world.⁴

In 2014, 387 million people worldwide were estimated to have diabetes mellitus (DM) by the International Diabetes Federation (IDF). Out of these, nearly one in 10 Indian adults were afflicted by the illness.

The burden of this non-communicable disease has dramatically increased⁵. Therefore, it is of significant interest to identify modifiable risk factors and predictors for the development of Type 2 Diabetes.

Sarcopenic Obesity is obesity combined with a decline in skeletal muscle mass, strength, and athletic performance.^{6,7} Obesity is specifically linked to Insulin resistance, which causes hyperglycemia, hypertension, dyslipidemia, and other metabolic disorders^{7,8}.

This study aims to provide insights into the relationship between body fat and muscle strength in patients with Type 2 Diabetes Mellitus.

Objective: The objective is to investigate the correlation between body fat, hand grip strength and metabolic health in individuals with type 2 Diabetes Mellitus.

Research Problem: The link between body fat, hand grip strength, and Type 2 Diabetes Mellitus remains unclear.

Theoretical Framework:

The interplay between body fat, muscle strength, and Type 2 Diabetes Mellitus is complex and multifaceted. Excess body fat, especially Visceral fat, contributes to Insulin resistance and Metabolic dysfunction^{4,9}.

Muscle strength, as measured by handgrip strength, is inversely related to metabolic risk factors^{10–12}. Understanding these relationships can help in developing interventions to improve health outcomes for T2DM patients.

METHODOLOGY

Search Strategy and Data Sources:

A comprehensive search was conducted using databases such as PubMed, Google Scholar, and Research Gate. Keywords used included "hand grip strength," "body fat," "Type 2 Diabetes Mellitus," and "Northern India." Articles published between 2000 and 2024 were included.

Selection Criteria

Studies included were those that assessed hand grip strength and body fat in patients with T2DM and those that explored the metabolic implications of these factors.

Studies were selected based on relevance to the topic among recent publications and quality of Research Methodologies used.

REVIEWS OF LITERATURE

Relationships between Body Fat and Type 2 Diabetes Mellitus

A study using Mendelian randomization analyses found that Obesity causally drives Prediabetes and Insulin resistance in Non-Diabetic individuals. Additionally, adipose cell-type composition, adipose MT gene expression and body fat percentage were identified as predictors of systemic Insulin Resistance.¹³

Zhang and associates also showed that the trunk and body fat percentage thresholds significantly increase the risk of Type 2 Diabetes in Chinese men and women.⁹

The systematic review and meta-analysis of observational studies conducted by Gupta et al. on the association between body composition indices assessed via dual energy X-ray absorptiometry (DXA) and Type 2 Diabetes Mellitus (T2DM) revealed a two-fold higher likelihood of low fat-free mass (FFM) in T2DM patients. Greater Visceral fat mass (VFM) was identified as a significant risk factor for both prevalence and incidence of T2DM. However the relationship of Type 2 Diabetes Mellitus with total body fat mass remained unclear¹⁴

Table 1: Insulin Resistance and Adipokines

Adipokine	Effect on Insulin Sensitivity	Plasma Level in Obesity	Source of Origin
TNF- α	Impaired	Raised	Adipocyte, Macrophage
IL-6	Impaired	Raised	Adipocyte, Macrophage
Resistin	Impaired	Raised	Adipocyte
Leptin	Variable/Impaired	Raised	Adipocyte
Adiponectin	Enhanced	Reduced	Adipocyte

Hand Grip Strength as Risk Factor of Diabetes

Hand grip strength (HGS) is one of the prospective health markers, especially in connection to long-term illnesses like Type 2 Diabetes Mellitus. Research from the UK Biobank shows that a weaker grip is linked to a higher risk of Diabetes. Although results vary from population to demographic, relative grip strength frequently shows higher associations with metabolic health.¹⁰ Cohort Study in South Korea examined this association and found no discernible variations in grip strength between Diabetic and Non-Diabetic individuals. This implies that the relationship between grip strength and Type 2 Diabetes may be modulated by extrinsic factors, including Glycemic management, Obesity and Physical activity levels.¹¹

Correlations between Body Fat and Hand Grip Strength

The relationship between body fat and handgrip strength is mutual. Obese individuals generally have lower muscle strength in anti-gravity muscles compared to their non-obese counterparts, relative to their body weight. Conversely, low muscle strength can lead to weight gain and obesity. Furthermore, individuals with Abdominal obesity show lower handgrip strength, irrespective of gender, indicating that abdominal fat negatively impacts overall muscle strength and daily tasks requiring grip strength.¹⁵

Palacio et al. examined the correlation between relative muscle strength and abdominal adiposity in healthy Chilean adults.

They discovered that men exhibited higher hand grip strength (HGS) than women, though HGS declined with age in both genders. Notably, individuals with Abdominal Obesity demonstrated lower RHGS, irrespective of age and gender.¹⁵

Similarly Lad and associates investigated the association between body mass index (BMI), body fat percentage, hand grip strength (HGS) and hand grip endurance (HGE), highlighting that the connection between BMI, body fat percentage and HGE varied based on gender differences.¹⁶ Muscle strength and metabolic health are known to be influenced by age, ethnicity and lifestyle choices.¹¹

Table 2: Summary of Literature Reviews

Studies	Objectives	Findings/Conclusion	Suggestions
<i>Tomlinson et al</i> PubMed Central 2016 ¹⁷	To investigate the established relationship between body fat and skeletal muscle strength and power from adolescence, through young adulthood, and into old age.	Obese individuals have lower muscle strength relative to body mass compared to non-obese persons	Future research should focus on the relationship between body fat percentage and muscle function in older adults with sarcopenic obesity, using advanced techniques.
<i>Ingrova et al</i> ¹⁸ 2017-01-01 ResearchGate	To investigate the relationship between hand grip strength and key aspects of body composition and size in young healthy adults.	The lowest correlations were observed between maximum hand grip strength (MHGS) and body fat percentage in both females and males, except for the upper right limb in males	The interconnections among various anthropometric variables warrant thorough examination
<i>Suda et al</i> ¹⁹ 12/2021	To evaluate the effectiveness of models that adjusted the relationship between hand grip strength and diabetes by using either body mass index (BMI) or fat-free mass (FFM).	Binary logistic models showed that increased handgrip strength reduced the likelihood of diabetes or prediabetes, as confirmed by both BMI and FFM models, even after adjusting for other factors.	Prospective and intervention studies, as well as a case-control design, are needed for more reliable results.
<i>Palacio et al</i> ¹⁵ 2022-2-23 PubMed Central	To examine the association between relative muscle strength and abdominal obesity in healthy Chilean adults.	A moderate inverse relationship was observed between waist circumference and relative hand grip strength (RHGS). Individuals with abdominal obesity exhibited lower RHGS, irrespective of age and gender.	Waist circumference (WC) and Hand grip strength (HGS) measurements should be standard protocols for healthcare professionals for the prevention and treatment of health issues from adulthood onwards.

<i>Lad et al</i> ¹⁶ 2013-01 PubMed	To explore the relationship between body mass index (BMI), body fat percentage, hand grip strength (HGS), and hand grip endurance (HGE)	The correlation between BMI, body fat percentage, and hand grip endurance varied between males and females.	Including a larger obese population in the study could reveal more significant correlations.
<i>Sun et al</i> ⁷ 2023-01-27	To examine the relationship between body fat percentage (BF%) and sarcopenia in older adults with Type 2 Diabetes Mellitus (T2DM)	Body fat percentage (BF%) negatively correlated with gait speed and was positively associated with Sarcopenia after adjusting for confounders. Conversely, higher BMI was negatively associated with sarcopenia.	Body fat percentage (BF%) serves as a more reliable predictor of sarcopenia risk than body mass index (BMI) in older adults with type 2 diabetes mellitus (T2DM)
<i>Bandyopadhyay et al</i> ²⁰ 2008-1 PubMed Central	To assess body composition and hand grip strength in male brick-field workers and contrast the results with their sedentary counterparts.	Daily labour in Brick-field workers prevented body fat accumulation and enhanced arm strength due to extensive use of hand and finger muscles	Establishing predictive norms for estimating body fat percentage from BMI can provide foundational insights into the body composition characteristics of the studied population.
<i>Dhar et al</i> ²¹ 2023	To examine and contrast the impact of body mass index (BMI) and body fat on muscle strength and endurance	Higher body fat percentage was significantly linked to lower muscle strength and endurance. Males had higher hand grip strength (HGS) and endurance (HGE).	Regional fat distribution and Biochemical markers of adiposity could offer a more thorough perspective on the subject.
<i>Wu et al</i> ²² 2023-08-02	To investigate the relationship between both absolute and relative hand grip strength (HGS) and the occurrence of Type 2 diabetes mellitus (T2DM).	The results suggest that relative HGS was better than absolute HGS in predicting incident T2DM.	Additional studies are necessary to validate these observations further.
<i>Söğüt et al</i> ²⁴ 2019-07-31 ResearchGate	To examine variations in, body fat percentage, and muscular strength among moderately physically active and highly physically active young men and women.	Higher physical activity is associated with lower body fat levels, but does not significantly impact grip strength.	Future studies should employ more advanced techniques to evaluate physical activity levels and body composition

RESULTS

Body Fat: Most studies indicate that Body fat especially, Visceral fat is significantly associated with insulin resistance, leading to higher blood glucose levels.^{13,14}

Hand Grip Strength: It is a measure of muscle function and overall physical fitness. Low hand grip strength is an indicator of reduced Glycemic control.^{6,10,11}

There is a negative correlation between hand grip strength and body fat with blood glucose levels. Higher body fat is generally associated with lower muscle strength and poorer Glycemic control.^{15,17–22,24,27}

Trends and Patterns: There is a consistent trend indicating that reduced Hand grip strength and higher body fat percentage are predictive markers for more severe Diabetes complications.^{15,17,18,19,21,24-27}

DISCUSSION

Critical Analysis of Studies

The reviewed studies provide important insights into the relationship between body fat percentage and hand grip strength (HGS) in patients with Type 2 Diabetes Mellitus (T2DM). Some studies have found the weakest correlations between maximum HGS (MHGS) and body fat percentage in both men and women.

However, differences have been noted between the genders. Despite these findings, there are several limitations, including small sample sizes and variability in measurement techniques across studies. Potential confounding factors such as varying comorbidities and lifestyle differences among patients, should be taken into account when interpreting the results.

CONCLUSION

The reviewed studies indicate a significant negative correlation between body fat, hand grip strength and glycemic control in individuals with Type 2 Diabetes Mellitus. High body fat percentage is associated with lower muscle strength and suboptimal metabolic health.

Comprehensive management strategies aimed at reducing body fat and improving muscle strength could substantially enhance glycemic control and overall health outcomes in T2DM patients.

Recommendations

Future research should prioritize long-term studies, encompassing a diverse patient population and consistent measurement protocols, to validate these findings.

Conflict of Interest: None

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