



Association of body composition and core muscle strength in type 2 diabetes patients aged 25 to 45 years

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Abstract

Background: Type 2 diabetes mellitus is associated with changes in body composition and muscle function. However, the relationship between body-composition parameters and deep core-muscle performance in younger and middle-aged adults with type 2 diabetes remains insufficiently explored.

Objective: To determine the association between body composition and core-muscle performance in adults aged 25–45 years with type 2 diabetes mellitus.

Methods: An observational cross-sectional study was conducted among 45 participants recruited through convenience sampling. Body composition was assessed using waist-to-hip ratio and a Karada bioelectrical impedance analyzer. *Transversus abdominis* and *Multifidus* performance was assessed using a pressure biofeedback unit. Descriptive statistics and Spearman's rank-order correlation were used.

Results: BMI was negatively associated with *Transversus abdominis* endurance ($\rho = -0.304$, $p = 0.042$). Skeletal muscle mass ($\rho = -0.425$, $p = 0.004$) and subcutaneous fat percentage ($\rho = -0.316$, $p = 0.034$) were negatively associated with *Transversus abdominis* strength. No statistically significant associations were observed between the other body-composition variables and *Transversus abdominis* or *Multifidus* outcomes.

Conclusion: Selected body-composition measures were associated with *Transversus abdominis* performance, whereas no significant associations were found with *Multifidus* performance. The findings should be interpreted cautiously because the study was cross-sectional and the pressure biofeedback unit provides an indirect pressure-based measure.

Keywords: Type 2 diabetes mellitus, body composition, core muscle, *Transversus abdominis*, *Multifidus*, pressure biofeedback unit

Introduction

Type 2 diabetes mellitus (T2DM) is one of the most rapidly rising metabolic disorders worldwide and is strongly linked with abnormalities in body composition and progressive decline in muscle function. Regular physical activity and improvement in muscular fitness are now recognized as essential components in diabetes care, as emphasized by professional bodies such as the American College of Sports Medicine and the American Diabetes Association, who jointly highlight the importance of muscle strength and body composition management in individuals with T2DM [1]. Patients often exhibit increased fat accumulation, reduced skeletal muscle mass, and altered fat-to-muscle ratios, all of which significantly influence metabolic health and long-term disease progression. Recent research has shown that the relative proportion of fat and muscle plays a crucial role in determining the metabolic status of individuals with diabetes. Studies using bioelectrical impedance analysis (BIA) demonstrate that higher regional or total fat-to-muscle ratios are strongly associated with insulin resistance and the development of T2DM [2]. Additionally, racial and ethnic differences in BMI-adiposity relationships further complicate the interpretation of obesity and metabolic risk among diverse populations, making body composition analysis a more reliable indicator than BMI alone [3]. Loss of skeletal muscle mass, particularly appendicular muscle

mass, and increases in visceral fat contribute to metabolic syndrome components such as inflammation, arterial stiffness, and impaired glucose regulation [4]. Core musculature plays a central role in maintaining spinal stability, posture, functional capacity, and overall physical performance. Weakness in core muscles can impair mobility and increase the risk of musculoskeletal complications, especially in individuals with chronic metabolic diseases. Evidence suggests that spinal stability and abdominal muscle activation may be influenced by obesity and altered intra-abdominal pressure, conditions frequently observed in diabetic individuals [5]. Moreover, anthropometric indicators such as waist-hip ratio have shown superiority over BMI in predicting metabolic and liver-related outcomes [7]. This further reinforces the need to evaluate fat distribution patterns and muscle strength together rather than relying solely on BMI.

Methodology

Study design and participants

An observational cross-sectional study was conducted in Navi Mumbai, Maharashtra, India. Forty-five adults aged 25–45 years with T2DM were included using convenience sampling. The sample size was calculated using OpenEpi. Participants had been diagnosed with T2DM for more than one year and included both male and female participants.

Eligibility criteria

Participants were eligible if they were aged 25–45 years, had T2DM, had a diabetes duration of more than one year, and were willing to participate. Participants were excluded if they had recent abdominal or spinal surgery; known congenital, musculoskeletal or neurological conditions; regular gym, athletic or structured core-strengthening training during the previous six months; prolonged corticosteroid use; pregnancy or recent postnatal status; pacemakers or implants; edema; or fluid imbalance.

Outcome measures

Body composition was assessed using waist-to-hip ratio and a Karada bioelectrical impedance analyzer. The analyzer estimates body-fat percentage, visceral fat, skeletal muscle mass, basal metabolic rate and subcutaneous fat using bioelectrical impedance. Core-muscle performance was assessed using a pressure biofeedback unit (PBU). For *Transversus abdominis* assessment, the PBU was placed under the lumbar spine in crook lying and inflated to 40 mmHg; the abdominal drawing-in maneuver was performed and the pressure response was recorded. For *Multifidus* assessment, the PBU was placed under the lower abdomen in prone lying and inflated to 70 mmHg. The recorded pressure responses were used as indicators of muscle performance and control.

Data collection procedure

Ethical approval was obtained from the Institutional Ethics Committee of TMV's Lokmanya Tilak College of Physiotherapy, Kharghar. The study purpose and procedure were explained to eligible participants, and written informed consent was obtained. Demographic and clinical information, including age, sex,

occupation, duration of diabetes and medication use, was recorded. Waist-to-hip ratio and body-composition parameters were assessed using the Karada analyzer. *Transversus abdominis* and *Multifidus* performance was then assessed using the PBU. All measurements were conducted by the same assessor, with adequate rest between assessments.

Ethical considerations

Ethical approval was obtained from the Institutional Ethics Committee of TMV's Lokmanya Tilak College of Physiotherapy, Kharghar. Permission to conduct data collection was obtained from the relevant authorities. Written informed consent was obtained from all participants, and confidentiality of participant information was maintained.

Statistical analysis

Data were analysed using IBM SPSS Statistics version 26.0. Continuous variables were presented as mean $\pm$ standard deviation and median with interquartile range. Normality was assessed using the Shapiro–Wilk test. Spearman's rank-order correlation was used to examine associations between body-composition variables and core-muscle outcomes. All tests were two-tailed, and $p < 0.05$ was considered statistically significant.

Data Analysis and Result

The study included 45 participants with T2DM. The mean age was 42.60 ± 3.44 years, and 27 participants (60%) were female. The mean duration of diabetes was 2.94 ± 2.08 years. Most participants (97.8%) were using oral antidiabetic medication, while 2.2% were using both oral medication and insulin.

Table 1: Anthropometric and body-composition characteristics of participants.

Variable	Mean $\pm$ SD	Median (IQR)
BMI (kg/m ²)	25.84 $\pm$ 2.96	25.8 (23.55–27.5)
Waist-to-hip ratio	0.87 $\pm$ 0.05	0.88 (0.83–0.91)
Body fat (%)	32.26 $\pm$ 4.68	32.5 (30.55–34.85)
Visceral fat	12.28 $\pm$ 4.41	12 (8.5–13.7)
Skeletal muscle mass	29.08 $\pm$ 6.23	29.2 (25.25–34.35)
Basal metabolic rate (kcal/day)	1527.02 $\pm$ 183.72	1502 (1362.5–1669)
Subcutaneous fat (%)	24.47 $\pm$ 4.00	24 (21.05–27.65)

Table 2: Core-muscle performance characteristics.

Core-muscle outcome	Mean $\pm$ SD	Median (IQR)
<i>Transversus abdominis</i> strength (mmHg)	−2.55 $\pm$ 1.32	−2 (−4 to −1)
<i>Transversus abdominis</i> endurance	8.62 $\pm$ 1.77	10 (7.5–10)
<i>Multifidus</i> strength (mmHg)	3.07 $\pm$ 1.60	3 (2–4)
<i>Multifidus</i> endurance	8.60 $\pm$ 1.68	10 (7.5–10)

Table 3: Selected correlations between body-composition variables and *Transversus abdominis* outcomes. $p < 0.05$.

Body-composition variable	Outcome	Spearman's ρ	p-value
BMI	TrA endurance	−0.304	0.042
Skeletal muscle mass	TrA strength	−0.425	0.004
Subcutaneous fat	TrA strength	−0.316	0.034
WHR	TrA strength	0.178	0.242
Body fat	TrA strength	0.248	0.100
Visceral fat	TrA strength	0.011	0.941
BMR	TrA strength	−0.027	0.860

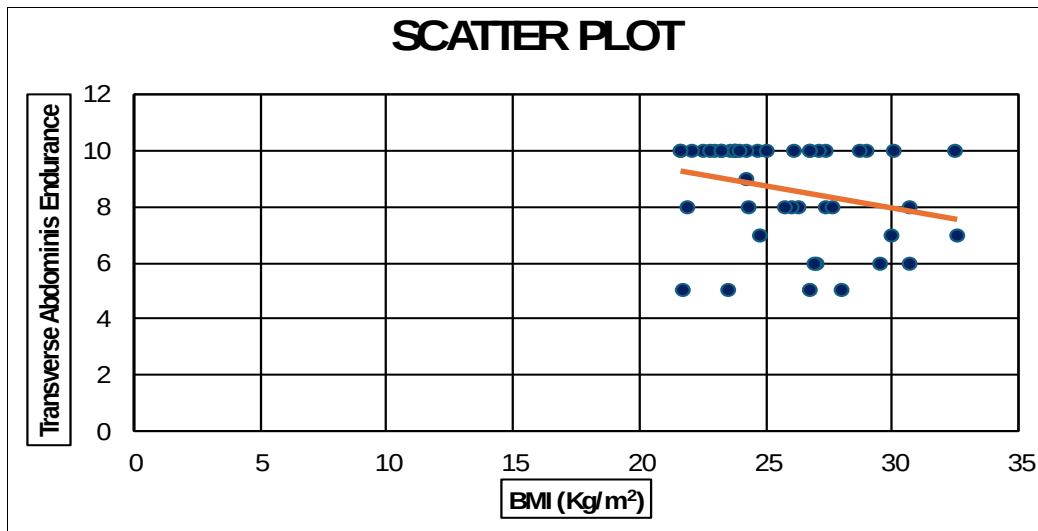


Fig 1: Scatter plot representing relationship between BMI and *Transversus abdominis* endurance of the participants. BMI showed a significant negative association with *Transversus abdominis* endurance ($\rho = -0.304$, $p = 0.042$)

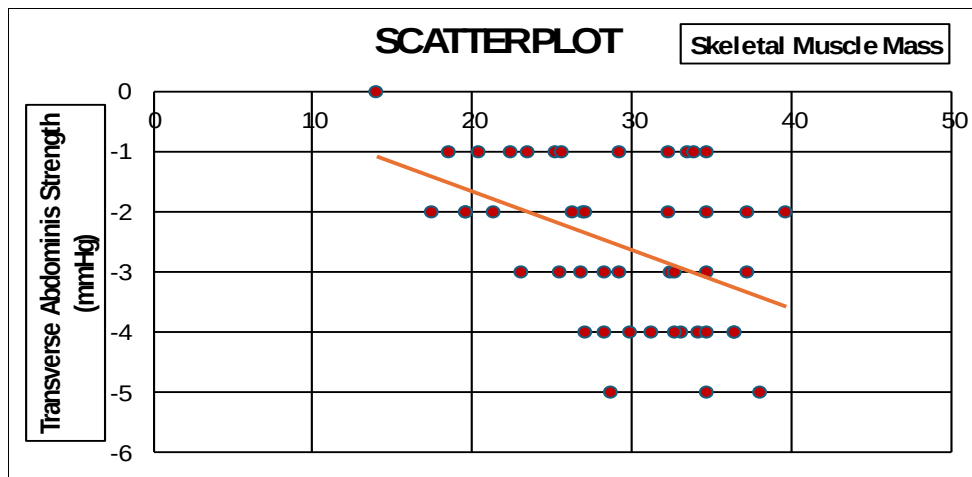


Fig 2: Scatter plot representing relationship between skeletal muscle mass and *Transversus abdominis* strength of the participants. A moderate negative significant correlation was observed between skeletal muscle mass and *Transversus abdominis* strength ($\rho = -0.425$, $p = 0.004$)

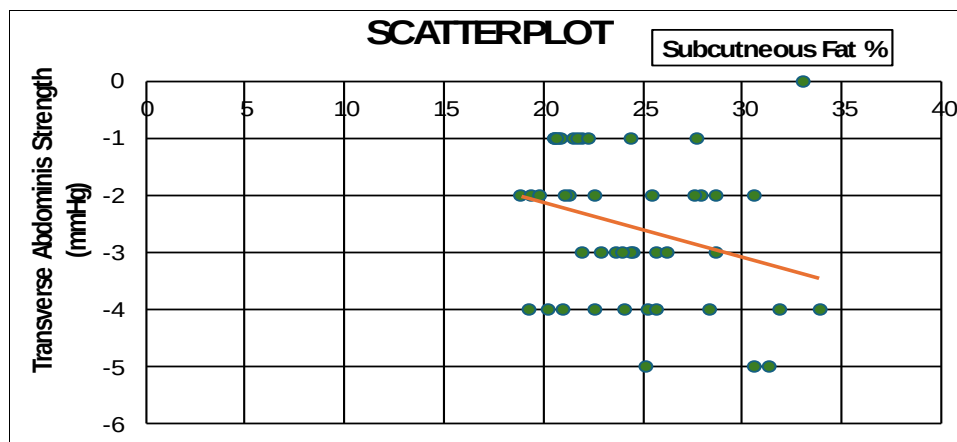


Fig 3: Scatter plot representing relationship between subcutaneous fat and *Transversus abdominis* strength of the participants. Subcutaneous fat percentage showed a statistically significant moderate negative correlation with *Transversus abdominis* strength ($\rho = -0.316$, $p = 0.034$). No statistically significant associations were identified between the assessed body-composition variables and *Multifidus* strength or endurance.

Discussion

The present study investigated the association between body composition and core muscle performance in individuals with type 2 diabetes mellitus (T2DM). Among the 45 participants, significant associations were observed between BMI and *Transversus abdominis* (TrA) endurance ($p = -0.304$, $p = 0.042$), skeletal muscle mass and TrA strength ($p = -0.425$, $p = 0.004$), and subcutaneous fat percentage and TrA strength ($p = -0.316$, $p = 0.034$). No significant associations were observed between the other body-composition variables and TrA or *Multifidus* strength and endurance.

The significant negative association between BMI and TrA endurance suggests that participants with higher BMI tended to demonstrate lower TrA endurance. This finding may be related to the effects of increased body mass and adiposity on trunk muscle function. However, BMI does not differentiate between fat mass and muscle mass, and therefore it cannot independently explain changes in muscle performance. Previous evidence has shown that different components of body composition have different relationships with metabolic health, highlighting the importance of assessing body composition beyond BMI alone [12].

A significant negative association was also found between skeletal muscle mass and TrA strength ($p = -0.425$, $p = 0.004$), representing the strongest association observed in the present study. Skeletal muscle plays an important role in glucose metabolism and insulin sensitivity, and individuals with T2DM have an increased risk of reduced muscle mass and muscle function. A systematic review and meta-analysis reported that sarcopenia is relatively common among individuals with T2DM and that diabetes-related factors may contribute to impaired skeletal muscle health [13]. More recent evidence has also demonstrated that greater skeletal muscle mass and muscle strength are associated with a lower risk of T2DM [14]. However, the negative direction observed in the present study should be interpreted carefully because TrA strength was assessed using a pressure biofeedback-derived measure. Thus, the result indicates an association between skeletal muscle mass and the recorded TrA pressure response and should not be interpreted as evidence that greater skeletal muscle mass directly causes reduced TrA strength.

The present study further demonstrated a significant negative association between subcutaneous fat percentage and TrA strength ($p = -0.316$, $p = 0.034$). This finding suggests that greater subcutaneous adiposity was associated with the measured TrA pressure response. Body fat distribution is an important consideration in T2DM, although different fat compartments may demonstrate different relationships with metabolic and functional outcomes. A systematic review reported a strong association between visceral adiposity and T2DM, while relationships with other body-composition components were less consistent [15]. A recent 2026 systematic review further demonstrated that body-fat mass, trunk fat, visceral fat and body-fat percentage, as well as skeletal muscle mass, have distinct associations with T2DM risk [16].

Interestingly, the present study did not find significant associations between visceral fat or total body fat percentage and TrA or *Multifidus* performance. This suggests that the relationship between body composition and core muscle performance may be specific to particular

body-composition components rather than being a generalized effect of adiposity. Similarly, none of the body-composition variables showed significant associations with *Multifidus* strength or endurance. Differences between TrA and *Multifidus* findings may be related to their different anatomical and functional roles, as well as the specific pressure-based assessment method used in the present study. The findings should also be interpreted in light of previous research concerning pressure biofeedback assessment. Evidence suggests that pressure biofeedback and direct imaging methods do not always provide identical information regarding TrA activation, indicating that pressure-based measurements may reflect aspects of abdominal pressure control rather than direct muscle force. [17] Therefore, the significant associations observed in the present study should be considered associations with the measured core-muscle performance variables rather than direct evidence of changes in muscle strength.

Overall, the present findings suggest that selected components of body composition—particularly BMI, skeletal muscle mass and subcutaneous fat—are associated with TrA performance in individuals with T2DM, whereas these associations were not observed consistently across all body-composition variables or *Multifidus* outcomes. These findings support the importance of considering both adiposity and skeletal muscle characteristics when assessing individuals with T2DM. However, because the study is cross-sectional and includes a relatively small sample, causal relationships cannot be established. Further studies with larger samples and direct assessment methods such as ultrasound imaging or electromyography are recommended to better understand the relationship between body composition and core muscle performance.

Limitations

The sample size was limited to 45 participants, and convenience sampling may have introduced selection bias. The cross-sectional design does not permit causal interpretation. Participants were restricted to the 25–45-year age range and were recruited from a single setting, which may limit generalisability. The PBU provides an indirect pressure-based measure rather than direct measurement of muscle force or activation. In addition, factors such as physical activity, glycaemic control, nutrition, medication effects and muscle quality were not included in the correlation analysis.

Conclusion

Selected body-composition variables were associated with *Transversus abdominis* performance in adults with T2DM. BMI was negatively associated with *Transversus abdominis* endurance, while skeletal muscle mass and subcutaneous fat percentage were negatively associated with *Transversus abdominis* strength. No significant associations were observed between the assessed body-composition variables and *Multifidus* strength or endurance. These findings indicate association rather than causation and should be confirmed using larger studies and more direct assessment methods.

Clinical implication

Body composition may be considered alongside core-muscle performance during physiotherapy assessment of individuals with T2DM. Assessment of adiposity, skeletal

muscle characteristics and *Transversus abdominis* performance may provide additional information for individualised rehabilitation planning. However, the present findings do not establish that changing a particular body-composition parameter will necessarily improve core-muscle performance.

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