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THE RELATIONSHIP BETWEEN BODY COMPOSITION, LUMBAR STRENGTH, AND LUMBAR FLEXIBILITY IN PHYSIOTHERAPY STUDENTS

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ABSTRACT

Lumbar fitness, which encompasses lumbar flexibility and strength, is a critical component of trunk stability and physical function among health sciences students, and body composition indicators may influence these characteristics. This study aimed to analyze the relationship between six body composition indicators (weight, body fat percentage, visceral fat, resting metabolic rate, body mass index, and body age) and lumbar flexibility and strength. A non-experimental correlational study was conducted involving 51 physiotherapy students. Body composition was measured using a bioelectrical impedance analyzer, lumbar flexibility using the Sit & Reach Test, and lumbar strength using a back dynamometer. Data were analyzed using Spearman's rho because several variables were not normally distributed. Lumbar flexibility was significantly negatively correlated with weight ($rs = -0.345$, $p = 0.013$), whereas the other indicators showed no significant association ($p > 0.05$). Lumbar strength was significantly correlated with all six indicators ($p < 0.05$): resting metabolic rate ($rs = 0.626$, $p < 0.001$), weight ($rs = 0.506$, $p < 0.001$), visceral fat ($rs = 0.486$, $p < 0.001$), body age ($rs = 0.333$, $p = 0.016$), body mass index ($rs = 0.309$, $p = 0.027$), and body fat percentage ($rs = -0.280$, $p = 0.047$). Higher body weight was associated with lower lumbar flexibility, whereas higher resting metabolic rate, body weight, and visceral fat were associated with greater lumbar strength; in contrast, higher body fat percentage was associated with lower lumbar strength. These cross-sectional associations do not imply causality.

Keywords: *Body composition, lumbar flexibility, lumbar strength, resting metabolic rate, physiotherapy students.*

INTRODUCTION

Lumbar spine health and physical fitness are crucial for maintaining postural stability and preventing musculoskeletal disorders. In physiotherapy education, students are frequently exposed to heavy physical demands during clinical practice and practical training, making core stability and lumbar functionality paramount. Lumbar fitness is primarily projected through two physical performance parameters: trunk flexibility, which reflects joint range of motion (ROM), and lumbar muscle strength, which reflects core force generation capacity. Health-related fitness components, including body composition, muscular strength, and flexibility, are commonly used to profile university students (Geanta et al., 2025; Liguori et al., 2022), and a high prevalence of non-specific low back pain has been reported among physiotherapy students (Cela, 2021).

Over the past decade, body composition has been recognized as a major determinant of physical performance and musculoskeletal health (Chan et al., 2025; Li et al., 2025).

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Body composition encompasses not only general indicators like Body Mass Index (BMI) and total weight, but also detailed adiposity and metabolic parameters, such as body fat percentage, visceral fat level, resting metabolic rate (RMR), and biological body age. Excess adiposity is commonly hypothesized to cause mechanical restrictions and structural degradation, whereas fat-free mass (FFM) contributes positively to force production (Dhar & Purwar, 2023; Moncada-Jiménez et al., 2023).

However, previous studies exhibit inconsistent findings regarding the exact relationship between specific body composition metrics and localized lumbar functionality. For example, body fat percentage, but not BMI, was inversely correlated with handgrip strength in young adults (Dhar & Purwar, 2023), overweight and obesity were associated with lower trunk muscle torque and power in adolescents (Al-Shenqiti & Emara, 2021), and body composition variables were not significantly correlated with back pain severity in firefighters (Sanregret et al., 2023). General macro markers like BMI often fail to show a linear relationship with joint flexibility, as flexibility is heavily mediated by soft tissue elasticity, ligament compliance, and muscle stiffness rather than fat deposition alone (Primasoni 2023; Wispayani et al., 2024). Conversely, muscle strength is closely related to lean muscle mass (Moncada-Jiménez et al., 2023; Sari et al., 2024), and trunk strength can be expressed in absolute terms or relative to body weight and muscle mass, the latter being an indicator of muscle quality (Reyes-Ferrada et al., 2022).

Despite these insights, comprehensive studies evaluating all six primary body composition parameters—Weight, Body Fat Percentage, Visceral Fat, Resting Metabolic Rate, BMI, and Body Age—simultaneously against localized lumbar flexibility and strength remain limited. Recent studies in young adults have largely emphasized BMI and/or body fat percentage as the main body composition indicators (Dhar & Purwar, 2023; Li et al., 2025; Wispayani et al., 2024). Accordingly, the simultaneous assessment of six body composition indicators (weight, body fat percentage, visceral fat, resting metabolic rate, BMI, and body age) in relation to both lumbar flexibility and lumbar strength represents the specific contribution of this study. Understanding these specific correlations provides essential baseline data for designing targeted exercise interventions and ergonomic posture strategies for physiotherapy students. For example, identifying which indicators are associated with lumbar strength or flexibility can help prioritize lumbar extensor strengthening, flexibility training, and body composition–oriented conditioning, as well as posture and load-handling strategies during clinical practice for students with less favorable profiles. Therefore, this study aims to evaluate the correlation between six body composition parameters and lumbar fitness performance (lumbar strength and flexibility).

RESEARCH METHOD

This study utilized a quantitative correlational design to analyze the association between body composition metrics and lumbar physical performance parameters. A total of 51 active undergraduate physiotherapy students (N = 51) participated in this research.

Participants were recruited using purposive sampling.The inclusion criteria were active students of the physiotherapy program aged 17 – 25 years, willing to participate, and providing informed consent.The exclusion criteria were current low back pain, history of lumbar injury or surgery, musculoskeletal or neurological disorders, or inability to complete the tests. The sample size of 51 participants was determined using on total in which all eligible students of the physiotherapy program who met the inclusion criteria and did not meet any of the exclusion criteria during the data collection period were included.

Data Collection Procedures

Body Composition Assessment

Six body composition parameters—Weight (kg), Body Fat Percentage (%), Visceral Fat Level, Resting Metabolic Rate (kcal), Body Mass Index (kg/m²), and Body Age (years)—were measured using a calibrated digital Bioelectrical Impedance Analysis (BIA) device (brand: Omron, model: HBF-375, manufacturer: Omron Healthcare, country: China) under standardized morning resting conditions. Each participant was measured once, and the single value was used for analysis.

Lumbar Flexibility Measurement

Lumbar and hamstring flexibility was assessed using the standard Sit & Reach Test (Liguori et al., 2022), which reflects lower back and hamstring flexibility (Li et al., 2025). Participants were instructed to sit with knees fully extended and reach forward slowly along the measuring box. The maximal distance reached in centimeters was recorded. The test was performed three times, and the best value was used for analysis.

Lumbar Strength Measurement

Lumbar extensor muscle strength was measured using a digital Back Dynamometer (brand: Takei, model: TKK 5002, manufacturer: Takei Scientific Instruments, country: Japan). Participants stood on the dynamometer platform with legs straight, bent slightly forward at the hips (approximately. 30 degrees), holding the bar, and exerted maximal isometric upward lifting force using their back muscles. Force produced was measured in kilograms-force (kgf). The test was performed three times with a rest interval of five seconds between trials, and the best value was used for analysis.

Statistical Analysis

Data were tabulated and tested for normality using the Shapiro–Wilk test (Ghasemi & Zahediasl, 2012). The results showed that lumbar flexibility was not normally distributed ($p < 0.05$), whereas body composition variables were normally distributed ($p \geq 0.05$). Because several variables violated the normality assumption, non-parametric statistical methods were employed. Hypotheses were tested using Spearman's Rho Correlation (r_s) to determine the direction, strength, and significance level of correlations between variables, with statistical significance set at $p < 0.05$. Spearman's rank

correlation is appropriate for continuous variables that are not normally distributed (Schober et al., 2018).

RESULTS AND DISCUSSION

Results

The study evaluated the relationship between six body composition indicators and two lumbar fitness parameters across 51 subjects (N = 51). The summary of the Spearman's Rho correlation analysis is presented in Table 1.

Table 1. Summary of Spearman's Rho Correlation Analysis Output

Body Composition Indicator	Lumbar Flexibility (Sit & Reach Test)		Lumbar Strength (Back Dynamometer)	
	r_s	p	r_s	p
Weight	-0.345*	0.013	0.506**	< 0.001
Body Fat Percentage	0.075	0.602	-0.280*	0.047
Visceral Fat	-0.231	0.102	0.486**	< 0.001
Resting Metabolic Rate	-0.117	0.415	0.626**	< 0.001
Body Mass Index (BMI)	-0.206	0.148	0.309*	0.027
Body Age	-0.205	0.147	0.333*	0.016

** Correlation is significant at p < 0.05 level; ** Correlation is significant at p < 0.01 level.*

Analysis of Body Composition vs. Lumbar Flexibility

Out of the six body composition parameters (Table 1), only body weight demonstrated a statistically significant correlation with lumbar flexibility (r_s = -0.345, p = 0.013). This indicates a weak-to-moderate inverse association, in which participants with higher body weight tended to have lower lumbar flexibility. This finding reflects a correlation and does not imply that higher body weight directly causes reduced lumbar flexibility. The remaining five indicators—Body Fat, Visceral Fat, Resting Metabolic Rate, BMI, and Body Age—showed no statistically significant linear association with lumbar flexibility (p > 0.05).

Analysis of Body Composition vs. Lumbar Strength

In contrast to flexibility, all six body composition indicators showed statistically significant correlations with lumbar muscle strength (p < 0.05; Table 1).

1) Body Fat Percentage exhibited a weak negative correlation (r_s = -0.280, p = 0.047), indicating that higher body fat percentage was associated with lower lumbar extensor force output.
2) The other five indicators demonstrated positive correlations with lumbar strength:
   a. Resting Metabolic Rate: Strong positive correlation (r_s = 0.626, p < 0.001).
   b. Weight: Moderate positive correlation (r_s = 0.506, p < 0.001).
   c. Visceral Fat: Moderate positive correlation (r_s = 0.486, p < 0.001).
   d. Body Age: Weak positive correlation (r_s = 0.333, p = 0.016).
   e. BMI: Weak positive correlation (r_s = 0.309, p = 0.027).

Discussion

Relationship Between Body Composition and Lumbar Flexibility

The observed negative correlation between total body weight and lumbar flexibility (r_s = -0.345) may be explained through biomechanical principles. Greater body mass may increase the mechanical load on the lumbar segments and soft-tissue approximation during trunk flexion, which may limit joint range of motion (ROM); however, causality cannot be inferred from the present cross-sectional design.

Interestingly, specific adiposity markers like total fat percentage and visceral fat did not correlate linearly with flexibility. This reinforces existing biomechanical literature suggesting that trunk flexibility is primarily dictated by intra-articular elasticity, tendon compliance, ligamental laxity, and muscle stiffness, rather than subcutaneous or abdominal fat volume alone. As reported by Primasoni (2023), BMI showed no significant correlation with hamstring flexibility in junior football athletes, indicating that macro anthropometric indicators like BMI frequently fail to reflect direct joint flexibility possibly because of structural variations in soft tissue compliance. In line with this, BMI was not related to hamstring flexibility in physiotherapy students assessed with the Sit & Reach Test (Wispayani et al., 2024), which parallels the non-significant BMI correlation observed here (r_s = -0.206, p = 0.148). Because the Sit & Reach Test reflects both lower back and hamstring flexibility (Li et al., 2025), the weight-related association should be interpreted cautiously, as hamstring extensibility may also have contributed to the test score. This suggests that general body-size indices only partially explain flexibility performance, and that soft-tissue extensibility and habitual physical activity should be considered in future studies.

Relationship Between Body Composition and Lumbar Strength

The most profound finding of this research is the strong positive correlation between Resting Metabolic Rate (RMR) and lumbar muscle strength (r_s = 0.626). Physiologically, resting metabolic rate is largely determined by fat-free mass (FFM), i.e., metabolically active lean tissue (Hopkins et al., 2023; Zhou et al., 2024). Individuals with higher RMR may therefore possess greater active skeletal muscle mass, including core stabilizer muscles such as the *erector spinae* and *multifidus*, which may allow for greater motor unit recruitment during maximal isometric extension on a back dynamometer. This interpretation is consistent with reports that lean or muscle mass is positively associated with muscle strength (Chan et al., 2025; Moncada-Jiménez et al., 2023; Sari et al., 2024), although lean mass was not directly measured in the present study.

Conversely, body fat percentage showed an inverse relationship with lumbar strength (r_s = -0.280). Excessive systemic fat deposition may be accompanied by intramuscular lipid accumulation (myosteatosis), which has been proposed to reduce contractile efficiency and force generation capacity (Dhar & Purwar, 2023); however, intramuscular fat was not assessed in this study. The inverse association is consistent with the negative correlation between body fat percentage and muscle strength reported in young adults (Dhar & Purwar, 2023) and with lower trunk muscle torque and power

among overweight and obese adolescents (Al-Shenqiti & Emara, 2021).

The positive associations observed with weight (r_s = 0.506) and visceral fat (r_s = 0.486) may reflect a functional structural adaptation (compensatory hypertrophy). Individuals with higher body mass and abdominal load may regularly subject their posterior chain muscles to sustained static loading during daily activities, potentially conditioning their lumbar extensors to maintain postural integrity against gravity. These interpretations are in line with Lee and Kang (2016), who examined lumbar function and body composition together in patients with chronic back pain. The findings, however, are not uniform across populations: overweight and obese adolescents showed lower isokinetic trunk torque and power (Al-Shenqiti & Emara, 2021), whereas weight was positively associated with strength in the present young adult sample. This difference may be related to age, test modality (isokinetic versus isometric back dynamometry), and the use of absolute rather than relative strength, the latter being an indicator of muscle quality (Reyes-Ferrada et al., 2022).

Limitations, the cross-sectional correlational design precludes causal inference, and the bivariate correlations were not adjusted for potential confounders such as sex and physical activity level. BIA estimates may differ from dual-energy X-ray absorptiometry (Mecherques-Carini et al., 2024), the Sit & Reach Test reflects hamstring as well as lumbar flexibility, and the relatively small sample (N = 51) limits generalizability. Longitudinal or interventional studies are needed to confirm these associations.

Novelty. The novelty of this study lies in the simultaneous analysis of six body composition indicators—weight, body fat percentage, visceral fat, resting metabolic rate, BMI, and body age—in relation to both lumbar flexibility and lumbar strength among physiotherapy students. Previous studies in young adults have mostly emphasized BMI and/or body fat percentage (Dhar & Purwar, 2023; Li et al., 2025; Wispayani et al., 2024). Evaluating the full set of indicators against two complementary lumbar outcomes in the same cohort shows that the indicators relate differently to flexibility and strength: only body weight was associated with flexibility, whereas all six indicators were associated with strength.

Practical implications, body composition screening using BIA can complement the Sit & Reach Test and back dynamometry in a multi-component fitness assessment for university students, in line with evidence that flexibility and BMI are linked to other fitness components in non-sports students (Apriyanto et al., 2024). For exercise planning, programs for physiotherapy students may combine lumbar extensor and core strengthening, aimed at maintaining or increasing lean mass while limiting excess body fat, with flexibility and posture-oriented exercises, particularly for students with higher body weight. For musculoskeletal health promotion, such screening may help identify students who could benefit from early education on exercise, load handling, and ergonomic posture during clinical practice, given the high prevalence of low back pain reported among physiotherapy students (Cela, 2021).

CONCLUSION

This study shows that body composition indicators are differentially associated with lumbar fitness components. Lower lumbar flexibility was associated with higher body weight, while the other adiposity markers were not significantly associated with flexibility. In contrast, lumbar strength was positively associated with resting metabolic rate, weight, visceral fat, body age, and BMI, whereas higher body fat percentage was associated with lower strength. Because of the cross-sectional design, these findings represent associations rather than causal effects. Exercise programming for physiotherapy students may consider limiting excess body fat while maintaining or enhancing lean muscle mass, together with core strengthening and flexibility training, to support lumbar health; this should be confirmed in longitudinal or interventional studies.

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