JSSF (11) (1) (2025)

Journal of Sport Sciences and Fitness

https://journal.unnes.ac.id/journals/jssf

Relative Leg Press Strength Related to Basal Metabolic Rate (BMR), Body Mass, And Body Fat in Female University Students: Implications for The Prescription of Exercise

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Article's Info

Article's History:
Submitted July 24, 2025
Revised August 24, 2025
Accepted August 25, 2025

Keywords:
leg press strength, Basal Metabolic Rate (BMR), body fat, body mass

DOI:
https://doi.org/10.15294/czab7026

Abstract

Introduction: Muscle strength affects metabolic activity and overall well-being, making it a critical component of physical fitness. Objectives: This study examines the relationship between university students' body weight, body fat, leg press strength, and Basal Metabolic Rate (BMR). **Method**: This study used a cross-sectional analytical design, selected using the purposive sampling technique with comprising female undergraduate students, sport coaching education enrolled in the Faculty of Sports Science at Surabaya State University, 56 participants with the following characteristics: who were aged (17.4 ± 2.7 years), had a height of (152.5 ± 29.47) cm, and had a weight of (55.15 ± 11.34 kg). **Result**: The results showed that there was a positive correlation between Basal Metabolic Rate (BMR) and leg press strength ($r = 0.283$, $p = 0.034$), indicating that greater lower body strength may help increase metabolism. In contrast, there was no significant correlation between body mass with leg press strength ($r = 0.197$, $p = 0.146$) and body fat with leg press strength ($r = -0.111$, $p = 0.417$), possibly due to individual differences in muscle distribution and fat storage. **Conclusion**: These findings emphasize the importance of strength training in improving weight control and metabolic health, especially in females. The study additionally highlights the necessity of additional investigation to gain a deeper comprehension of the mechanisms underlying these relationships and to explore other contributing factors. Overall, this study tells fitness experts how important a customized strength training program is for improving the metabolism and physical health of female college students.

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PISSN 2252-6528
EISSN 2745-5718

INTRODUCTION

Muscle strength is highly influential on physical fitness levels based on general body health and function (Suchomel et al., 2018). To improve performance and body composition, strength training, especially related to lower extremity muscles, such as the leg press, is commonly used by college-aged female athletes (Carter et al., 2022; Gardner et al., 2022). Further research is needed to completely understand how muscles strength and others physiological characteristics, such as body mass, body fat, and Basal Metabolic Rate (BMR) (De Lima et al., 2021). Additionally, young women may have different relationships with these variables compared to other population groups based on certain characteristics and behaviors (Banakh et al., 2023).

Several studies have shown that muscle strength, especially lower muscles, increases basal metabolic rate (BMR) through increasing the amount of active muscle mass that requires energy to be used during resting time (Siqueira et al., 2022; Stephan et al., 2023). Furthermore, it is likely that different relative strengths will be possessed by individuals with higher body mass or fat percentage (Zhao & Oleshko, 2022). However, there is not always a clear relationship between leg press relative strength and body mass and fat percentage (Carter et al., 2022). For example, in a study conducted by Saeterbakken et al. (2022) stated that body fat and muscle storage, as well as muscle mass differences between the upper and lower body, can all affect strength. This raises the question of whether body mass, body fat percentage, and Basal Metabolic Rate (BMR) can be used to calculate relative leg press strength.

It is currently unknown if some physical characteristics, especially among female college students, have a significant correlation with lower limb muscle strength. These characteristics include body mass, body fat, and Basal Metabolic Rate (BMR). The inconsistency of findings from previous studies raises questions about the existence and nature of the relationships between these variables. According to Mangine, Müller (2022); Sánchez-Delgado et al., (2023), although there is a relationship between strength and other physiological profiles, they highlighted that it is more closely associated with physical fitness, body mass, body fat, and basal metabolic rate (BMR). In addition, lower limb strength analyses often consider the fat distribution on a woman's larger torso and possible upper body muscle mass conditions.

To create a systematic and progressive training plan, it is crucial to understand some features of the body, such as body mass, body fat, and Basal Metabolic Rate (BMR) in connection to leg press strength, especially for female college students who want to increase muscle mass and reduce fat mass for a fitter and more beautiful look. This definitely does not happen without following a healthy lifestyle that helps decrease obesity and enhance general well-being. Consequently, this study will provide a more thorough explanation of the link to assist female college students in exercising as they choose after gaining an awareness of how each component is required to be more systematic, effective, and efficient.

This study was to explore the relationship between students' leg press strength as well as their muscle mass, fat mass, and basal metabolic rate (BMR). The findings demonstrated that whereas relative leg press strength and BMR were significantly correlated, leg press strength and neither body mass nor body fat were significantly correlated. In addition to raising BMR and a tiny amount of fat mass, an improvement in leg press strength is frequently correlated with an increase in active muscle mass. The torso and upper body have higher muscular mass than the lower limbs, which may explain the absence of correlation with body mass. This absence of correlation with body fat may be due to the substantial accumulation of fat in the trunk region, which has no bearing on leg press strength.

METHOD

This study used a cross-sectional analytical design, selected using the purposive sampling technique. Aiming to analyze the relationship between leg Press Strength Related To Basal Metabolic Rate (BMR), body mass, and body fat comprising female undergraduate students, sport coaching education enrolled in involved 56 participants who were aged (17.4 ± 2.7 years), had a height of (152.5 ± 29.47) cm, and had a weight of (55.15 ± 11.34 kg). Furthermore, there was no physical activity offered as part of the treatment.

The variables in this study were calculated using standardized instruments. During the measurement of leg press strength using the leg press exercise instrument. The Tanita BC-545N digital segment body composition scale is used to measure Basal Metabolic Rate (BMR), body weight, and body fat percentage. Using the test-retest method, the validity and reliability of the Tanita BC-545N Digital Segmental Body Composition Scale were examined, and the findings showed that it is a reliable tool. This guarantees that the information gathered for this research is authentic and appropriately reflects the current status of the variables being assessed.

Informing sports coaching education students of the research objectives and methodology is the first stage in the data collection process. Using the Tanita BC-545N Digital Segmental Body Composition Scale to quantify the subjects' body mass, body fat percentage, and Basal Metabolic Rate (BMR) after they met the requirements for participation. Strength was then measured using the leg press.

Measurement procedures are performed to assess BMR, body mass, body fat, and leg press strength, with the following steps:

1. Participants are gathered first to be informed about the operation of the Tanita BC-545N Digital Segmental Body Composition Scale and implementation of the leg press exercise for standardization.
2. The backrest is adjusted to an angle of 38° to the floor, while the feet are kept hip-width apart. Following this, participants perform a 15-minute warm-up consisting of 5 maximum

repetitions with the angle of the legs forming a 90° knee flexion during each leg press movement.

3. Afterward, participants perform the leg press to their maximum capacity, and once they are deemed to have reached their maximum, the results of their 5 maximum repetitions are recorded for each participant.

Secure data recording, validation, and storage for additional analysis guaranteed the participants' information's accuracy and confidentiality. The collected data were tested for normality using the Shapiro-Wilk test, then to determine the relationship between variables, Spearman's correlation test was used with a significance level of $p>0.05$.

RESULT AND DISCUSSION

For fifty-six, the data was complete. Although a correlation value was discovered, there was no significant positive link between Leg Press Strength and Body Mass, as compared with the results of the Basal Metabolic Rate (BMR) and Leg Press Strength tests. The data involved originated from the leg press strength of Surabaya State University undergraduate students registered in the Sports Coaching Education Year 2023 at the Faculty of Sports Science. The data was analyzed by Spearman correlation analysis to assess how the variables Basal Metabolic Rate (BMR), body mass, body fat, and leg press strength correlated with each other. However, baseline data was compiled and verified before Spearman's correlation analysis was used. Body mass, body fat, leg press strength, and Basal Metabolic Rate (BMR) were all measured using the Tanita BC-545N Digital Segmental Body Composition Scale. A normality test was carried out after the data were gathered, and Table 1 demonstrates that the data were not normally distributed.

Table 1. Normality Test from strength Leg Press Strength, Basal Metabolic Rate (BMR), body mass, body fat variable (N=56)

Test	Mean ± Sd	Sig.
Leg Press	67.76 ± 1.8	0.079
BMR	1236.6 ± 134.1	0.001
Body Mass	36.62 ± 5.4	0.200
Body Fat	28.56 ± 8.08	0.200

To determine if leg press strength was connected with body mass, body fat, and basal metabolic rate (BMR), a spearman correlation test was then performed, as shown in Table 2. During the normality test, which shows that the data is abnormally distributed, the Spearman correlation test is used to ascertain the association between Leg Press Strength and factors related to body mass, body fat, and basal metabolic rate (BMR).

Table 2. Correlation Spearman Test from Leg Press Strength, Basal Metabolic Rate (BMR), body mass, and body fat variable (N=56)

Test		BMR	Body Mass	Body Fat
Leg Press	Correlation Coefficient	0.283	0.197	-0.111
	Sig. (2-tailed)	0.034	0.146	0.417
	N	56	56	56

These results show a significant positive correlation (r = 0.283, p = 0.034) between basal metabolic rate (BMR) and leg press muscle strength. This suggests that higher muscle strength in the legs can help increase basal metabolism. Stronger muscles are typically associated with greater Basal Metabolic Rates (BMRs), which support healthier metabolisms and better weight control. This opinion is supported by Herda et al. (2023), who emphasize the connection between higher BMR and physical strength. Additionally, Henny et al. (2012) discovered that gender and age had a substantial impact on BMR, with younger people generally having more active metabolisms and continuing muscular growth. This relationship, however, is not always consistent as everyone is different (Sarafian et al., 2013). The basal metabolic rate of stronger participants is usually higher, meaning their bodies burn more calories at rest.

In contrast, of this study additionally showed that there was no significant correlation between body mass with leg press strength (r = 0.197, p = 0.146) and body fat with leg press strength (r = -0.111, p = 0.417), which is consistent with the findings of the according to a study by Debes et al. (2024), resistance training in older women with sarcopenic obesity resulted in a significant correlation but no discernible change in body mass or body fat. These results, however, are in contrast to those of Ormsbee et al. (2014), Trouwborst et al. (2018), and Sadaqa et al. (2023), who found that enhanced muscular function, strength, and growth led to a reduction in body fat %.

Based on this study, there is a beneficial relationship between leg press muscle strength and basal metabolic rate (BMR) because the leg press movement involves large muscles in the lower body, such as the quadriceps and hamstrings, which require high energy to work. Therefore, if leg press results are high, they can increase lower body muscle mass and strength, which then contributes to an increase in basal metabolic rate (BMR) because muscles remain active in burning energy even during rest. Additionally, there is the effect of Excess Post-Exercise Oxygen Consumption (EPOC), which causes the body to continue burning more energy even after the workout is finished. In other words, the leg press not only strengthens the body but also increases muscle strength, which boosts the basal metabolic rate (BMR) and supports overall weight management and metabolic health. This finding is consistent with a study by Cavedon et al. (2020), which found that higher leg press strength positively correlates with BMR. However, this does not apply to body mass and body fat in relation to leg press strength. This indicates that leg press strength does not automatically increase simply because it is influenced by large muscle mass and low body fat, but rather by high-quality neuromuscular factors, such as: the efficiency of the nervous system in activating muscles as a whole,

considering that larger muscle mass may also be accompanied by larger fat mass because muscle mass includes fat, whereas fat tissue cannot contract to generate the force required. This research aligns with that conducted by Hakkinen et al. (1992), which found that strength outcomes are more significantly influenced by maximal neural activation observed in the early stages of endurance training, reflecting the processes involved in motor learning due to exercise adaptation (Skarabot et al., 2021) compared to muscle hypertrophy, which is a fundamental concept in exercise physiology. Therefore, it is suggested that hypertrophy becomes a more dominant contributor to long-term strength gains after neural adaptation has been optimized in the initial stages. Based on these results, tailored strategies are needed for fitness programs that account for gender and age.

This is crucial for creating an exercise regimen that works. More research is needed to understand how outcomes differ based on strength, body structure, and health. This study's capacity to correlate leg press strength with Basal Metabolic Rate (BMR) offers crucial insights into the role strength training plays in healthcare. However, the limited sample size and diversity of participants restrict the generalizability of the study's findings. To achieve these outcomes, a customized exercise program should include body fat distribution, age, and gender for the purpose of better understanding the mechanisms underlying these relationships and to look into other factors that influence strength, body composition, and overall health. Fitness experts and trainers can apply this study to create more customized and effective training programs.

CONCLUSION

This study concluded that leg press strength has a significant positive correlation with Basal Metabolic Rate (BMR), but does not show a significant correlation with body mass or body fat. These findings suggest that muscle strength plays a more significant role in supporting metabolic function than mere changes in body composition. However, this study has limitations due to its relatively small sample size and homogeneous participant characteristics, so the results cannot yet be widely generalized. Therefore, future research is recommended to involve a larger number of participants with varied ages, genders, and physical conditions to gain a more comprehensive understanding of the relationship between muscle strength, body composition, and metabolic health, thereby enabling the creation of more tailored and effective exercise programs.

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