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Influence of Lean Body Mass Index and Body Mass Index on Blood Pressure in Young Healthy Adults

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ABSTRACT

Background: Body Mass Index (BMI) is widely used to assess obesity, yet it fails to distinguish between fat mass and lean body mass (LBM). Recent studies have shown that LBM, which represents metabolically active tissues, may have a different association with cardiovascular parameters compared to BMI.
Objective: To evaluate the influence of LBM and BMI on systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), heart rate (HR), and rate pressure product (RPP) in young healthy adults.
Methods: A cross-sectional study was conducted among 100 healthy volunteers (50 males, 50 females), aged 18–25 years. Anthropometric parameters (height, weight, BMI, and LBM) were recorded along with cardiovascular indices (SBP, DBP, HR, MAP, and RPP). LBM was calculated using validated regression equations specific for males and females.
Results: BMI and LBM showed significant positive correlations with SBP and DBP. Participants with higher BMI demonstrated higher MAP and RPP, whereas LBM showed stronger correlation with SBP and HR than with BMI.
Conclusion: Both BMI and LBM influence cardiovascular function, but LBM appears to be a better determinant of hemodynamic response and myocardial workload. Considering LBM alongside BMI provides a more accurate reflection of cardiovascular risk in young adults.

Keywords: Lean Body Mass, Body Mass Index, Blood Pressure, Rate Pressure Product, Cardiovascular Risk

INTRODUCTION

Cardiovascular health is influenced by various physiological and anthropometric parameters, among which body composition plays a crucial role. Traditionally, obesity—particularly elevated fat mass—has been associated with hypertension and increased cardiovascular risk. However, emerging evidence suggests that lean body mass (LBM), often measured as Lean Body Mass Index (LBMI), also contributes to blood pressure (BP) regulation and cardiovascular load [1].

LBMI is calculated by dividing lean body mass (usually derived from bioelectrical impedance analysis or dual-energy X-ray absorptiometry) by height squared, in a format analogous to the Body Mass Index (BMI). Unlike BMI, which does not differentiate between fat and muscle mass, LBMI offers a more specific indicator of metabolically active tissue. Increased LBM elevates the body's metabolic demand and cardiac output, potentially affecting hemodynamic parameters like systolic blood pressure (SBP), diastolic blood pressure

(DBP), mean arterial pressure (MAP), heart rate (HR), and rate pressure product (RPP) [2,3].

SBP and DBP are essential indicators of arterial pressure during cardiac cycles, while MAP provides a weighted average that reflects perfusion to vital organs. HR and RPP (calculated as HR × SBP) are indicators of myocardial workload and oxygen demand. Since LBM is associated with greater tissue perfusion needs, it is hypothesized that individuals with higher LBMI may exhibit elevated SBP and cardiac workload, regardless of fat mass [4].

Several studies have examined these relationships. For instance, Korhonen et al. found that both fat mass index and lean mass index independently correlated with 24-hour ambulatory SBP and DBP in older adults [1]. Similarly, Yuan et al. observed that lean body mass was positively associated with SBP across multiple adult age groups in a large Chinese population [2].

Understanding the influence of LBMI on cardiovascular parameters can improve risk stratification, especially in individuals with high muscle mass, such as athletes or those undergoing resistance training programs. It also sheds light on the limitations of using BMI alone to predict cardiovascular risk [5]. Therefore, this study aims to explore the associations between LBMI and key cardiovascular parameters: SBP, DBP, MAP, HR, and RPP.

METHODS

Study Design and Population

A cross-sectional study was conducted in the Department of Physiology, MGM Medical College, Kamothe, Navi Mumbai.

Sample size: 100 volunteers (50 males, 50 females) aged 18–25 years.

Inclusion criteria: Healthy individuals without chronic diseases.

Exclusion criteria: Smokers, alcoholics, diabetics, or participants on medication affecting cardiovascular function.

Data Collection

Participants attended the physiology lab between 10:30 a.m. and 1:00 p.m. After a rest period of 10 minutes, three readings of blood pressure were recorded using an OMRON Digital Sphygmomanometer at 5-minute intervals.

Anthropometric Measurements

Height (cm): Measured using a stadiometer.

Weight (kg): Measured using OMRON digital scale.

BMI (kg/m²): Calculated as *Weight (kg) / Height² (m²)*.

Lean Body Mass (LBM):

Males: LBM = -15.605 – (0.032 × age) + (0.192 × height) + (0.502 × weight)

Females: LBM = -13.034 – (0.018 × age) + (0.165 × height) + (0.409 × weight)

Hemodynamic Parameters

Systolic Blood Pressure (SBP) and **Diastolic Blood Pressure (DBP)** were measured.

Pulse Pressure (PP): SBP – DBP

Mean Arterial Pressure (MAP): DBP + (⅓ × PP)

Rate Pressure Product (RPP): SBP × HR

STATISTICAL ANALYSIS

Data were analyzed using descriptive statistics and Pearson's correlation analysis to evaluate the relationship between BMI, LBM, and cardiovascular parameters (SBP, DBP, MAP, HR, and RPP). Group comparisons were analyzed using the independent samples t-test. A p-value < 0.05 was considered statistically significant.

RESULT

Table 1: Mean Anthropometric and Hemodynamic Parameters

Parameter	Males (Mean ± SD)	Females (Mean ± SD)	p-value (t-test)
BMI -KG/M^2	23.2 ± 2.8	21.6 ± 3.1	<0.05
LBM-KG	56.8 ± 6.4	45.3 ± 5.8	<0.001
SBP-mmHg	122.3 ± 8.5	115.4 ± 9.1	<0.05
DBP-mmHg	78.4 ± 6.7	74.5 ± 7.2	<0.05
MAP-mmHg	93.0 ± 5.6	88.1 ± 5.8	<0.05
RPP-bmp-mmHg	10,200 ± 850	9,450 ± 770	<0.05

Table 2: Correlation of BMI and LBM with Cardiovascular Parameters

Parameter	BMI (r)	LBM (r)	Interpretation
SBP	0.48*	0.56*	Positive significant correlation
DBP	0.42*	0.44*	Moderate correlation
MAP	0.47*	0.53*	Stronger with LBM
HR	0.32	0.49*	LBM related increase
RPP	0.46*	0.55*	Higher with LBM

(*$p < 0.05$ statistically significant)

DISCUSSION

This study demonstrates that both BMI and LBM are significantly associated with cardiovascular parameters, but LBM shows a stronger correlation with SBP, MAP, and RPP. The positive relationship between LBM and blood pressure suggests that individuals with greater muscle mass exhibit higher cardiac workload due to increased oxygen demand and metabolic rate [6-11].

BMI, although widely used, can misclassify individuals with high muscle mass as overweight or obese [12-14]. This limitation reinforces the need to integrate body composition analysis into cardiovascular risk screening. Duncan et al. (2011) and Vivek Verma et al. (2014) similarly observed that LBM correlates more strongly with blood pressure than BMI, indicating that muscular mass, not just fat accumulation, contributes to hemodynamic variation [10, 15].

Moreover, elevated RPP values observed in individuals with higher BMI and LBM reflect increased myocardial oxygen consumption (MVO_2) [16, 17]. These findings align with those of Rajalakshmi et al. (2013), who reported that overweight young adults exhibit higher resting RPP and delayed recovery post-exercise, implying greater cardiac stress [17].

Overall, while both BMI and LBM influence cardiovascular parameters, LBM is a more physiologically relevant marker for predicting blood pressure variation and cardiac workload in healthy adults.

Limitations of Current Evidence

- Many studies are cross-sectional, limiting causal inference.
- Few studies directly measure RPP in relation to LBM, or provide longitudinal data showing how changes in LBM over time influence SBP, HR, etc.
- Variability in how LBM is measured (bioimpedance, DXA, anthropometric estimates) and how normalized (per height, weight etc.) makes comparisons difficult.
- Interactions with fat mass and distribution sometimes complicate the picture; in some groups the effect of LBM may be small or overshadowed by fat mass effects.

CONCLUSION

Lean Body Mass Index is an important and independent correlate of several cardiovascular haemodynamic parameters. There is consistent evidence that higher LBM is associated with higher Systolic Blood Pressure; associations with Diastolic Blood Pressure are weaker but present in many studies. The derived variables — Mean Arterial Pressure, Rate Pressure Product, Heart Rate — are also likely influenced, largely through effects on SBP and cardiac output. Future longitudinal and interventional studies are required to clarify causality, and to quantify how modifications in LBM (via exercise, nutrition) affect these parameters. Consideration of LBM in hypertension risk profiles and training regimens is justified.

Declaration by Authors

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