KLINIK : Jurnal Ilmiah Kedokteran dan Kesehatan
Volume. 4 Nomor. 2 Mei 2025
e-ISSN : 2809-2090; p-ISSN : 2809-235X, Hal. 432-444
DOI: https://doi.org/10.55606/klinik.v4i2.4078
Available online at: https://journalcenter.org/index.php/klinik

Simple Laboratory Variables and Anthropometry as A Predictor Parameter For Visceral Fat Deposition

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Abstract*: Visceral fat, associated with increased risks of chronic diseases like cardiovascular disease and diabetes, plays a crucial role in metabolic health. Its proximity to vital organs allows it to release harmful cytokines and hormones. While CT and MRI are the gold standard for assessing visceral fat, their cost and accessibility limits their use, highlighting the need for alternative methods. This study investigates the potential of simple laboratory variables such as hemoglobin and anthropometric measurements containing BMI, body height, and muscle mass as predictors of visceral fat. This study aims to identify practical, cost-effective tools for monitoring visceral fat, supporting disease prevention and management, particularly in limited resources settings. This study was conducted at St. Assisi Church with 32 respondents. Statistical analysis applies multiple linear regression to examine the relationship between anthropometric measurements, laboratory variables, and visceral fat. The multiple linear regression analysis identifies hemoglobin, body weight, body height, body fat, and arm total muscle as significant predictors of the dependent variable. Hemoglobin, body height, body fat, and arm total muscle show negative associations, while body weight positively predicts the outcome. These findings highlight the critical roles of these variables in influencing the dependent variable. This study identifies hemoglobin, body weight, height, fat, and arm muscle as significant predictors, highlighting muscle's critical role in functionality.*

Keywords*: Anthropometry, Predictor parameter, Simple laboratory, Visceral fat.*

Abstrak: Lemak visceral, yang terkait dengan peningkatan risiko penyakit kronis seperti penyakit kardiovaskular dan diabetes, memiliki peran penting dalam kesehatan metabolik. Kedekatannya dengan organ vital memungkinkan pelepasan sitokin dan hormon berbahaya. Meskipun CT dan MRI adalah standar emas untuk menilai lemak visceral, biaya dan keterbatasan aksesibilitasnya membatasi penggunaannya, sehingga menyoroti kebutuhan akan metode alternatif. Penelitian ini menyelidiki potensi variabel laboratorium sederhana seperti hemoglobin dan pengukuran antropometri, termasuk BMI, tinggi badan, dan massa otot, sebagai prediktor lemak visceral. Penelitian ini bertujuan untuk mengidentifikasi alat yang praktis dan hemat biaya untuk memantau lemak visceral, mendukung pencegahan dan pengelolaan penyakit, terutama di lingkungan dengan sumber daya terbatas. Penelitian ini dilakukan di Gereja St. Assisi pada bulan Desember 2024, dengan melibatkan 32 responden. Analisis statistik menggunakan regresi linier berganda untuk menguji hubungan antara pengukuran antropometri, variabel laboratorium, dan lemak visceral. Analisis regresi linier berganda mengidentifikasi hemoglobin, berat badan, tinggi badan, lemak tubuh, dan otot total lengan sebagai prediktor signifikan dari variabel dependen. Hemoglobin, tinggi badan, lemak tubuh, dan otot total lengan menunjukkan hubungan negatif, sedangkan berat badan secara positif memprediksi hasil. Temuan ini menyoroti peran penting variabel-variabel tersebut dalam memengaruhi variabel dependen. Penelitian ini mengidentifikasi hemoglobin, berat badan, tinggi badan, lemak, dan otot lengan sebagai prediktor signifikan, dengan menekankan peran kritis otot dalam fungsi tubuh.

Kata kunci: Antropometri, Laboratorium sederhana, Lemak visceral, Parameter prediktor

Received: April 19, 2025; Revised: Mei 03, 2025; Accepted: Mei 17, 2025; Published: Mei 19, 2025

1. INTRODUCTION

Visceral fat, which accumulates around internal organs, is a critical determinant of metabolic health and has been strongly associated with an increased risk of developing chronic diseases such as cardiovascular disease, type 2 diabetes, and metabolic syndrome. (Mathieu et al., 2009; Silveira et al., 2020) Visceral fat is particularly harmful due to its proximity to vital organs and its ability to release pro-inflammatory cytokines and hormones that can disrupt normal metabolic functions. (Mathieu et al., 2009; van Eekelen et al., 2019) Given its role in the pathogenesis of various diseases, effective monitoring and early detection of visceral fat accumulation are essential for preventive health strategies. (Miyawaki et al., 2004; Silveira et al., 2020)

While imaging techniques such as computed tomography (CT) and magnetic resonance imaging (MRI) are considered the gold standard for assessing visceral fat, they are not always practical due to their cost, time requirements, and lack of accessibility in many healthcare settings. (Ribeiro-Filho et al., 2001) As a result, there is a growing need for alternative, simpler methods that can reliably predict visceral fat deposition. (Woldemariam et al., 2018; Xu et al., 2021) Anthropometric measurements and basic laboratory variables are widely available and provide a cost-effective way to assess body composition and metabolic health. (Ribeiro-Filho et al., 2001; Woldemariam et al., 2018)

This study aims to explore the potential of simple laboratory variables, such as hemoglobin, and anthropometric measurements, including body height, body mass index (BMI), and muscle mass, as predictors of visceral fat. (Kuroiwa et al., 2019) Previous research has suggested that BMI and muscle mass may be linked to fat distribution, but their direct impact on visceral fat remains underexplored. (ChiSu et al., 2024; Hiremath et al., 2023) By analyzing the relationships between these parameters and visceral fat deposition, this research aims to provide valuable insights into how easily accessible factors can serve as reliable predictors. (Gokhale et al., 2019) Ultimately, the goal is to identify cost-effective and practical tools for monitoring visceral fat, which could significantly enhance disease prevention and management strategies, particularly in settings where advanced imaging techniques are not available. (Iwata et al., 2012)

2. LITERATURE REVIEW

Body weight is a variable often associated with increased visceral fat. Individuals with excess weight, especially those with obesity, tend to have higher visceral fat accumulation. Research indicates that weight gain disproportionate to muscle mass is linked to increased visceral fat. Fat accumulation in the abdominal area is often a key indicator of elevated visceral fat, contributing to a higher risk of metabolic diseases. (Castro et al., 2018; Ness-Abramof & Apovian, 2008; Song et al., 2023)

Waist circumference is a key indicator for assessing central obesity, which is closely linked to increased visceral fat. A larger waist circumference reflects fat distribution concentrated in the abdominal region, directly associated with higher visceral fat levels. Studies have shown that a larger waist circumference is correlated with a higher risk of insulin resistance, dyslipidemia, and hypertension. Therefore, waist circumference is often used as a clinical predictor to assess metabolic risk related to visceral fat. (Feng et al., 2023; Kalam et al., 2021; Ogawa, 2024)

Calf circumference, commonly used as an indicator of muscle mass, is also associated with visceral fat. Individuals with smaller calf circumference often have lower muscle mass, which can increase the risk of visceral fat accumulation. Low muscle mass is linked to a reduced basal metabolism and insulin resistance, contributing to greater visceral fat storage. Muscle loss or sarcopenia, especially in the elderly population, can worsen metabolic conditions associated with visceral fat accumulation. (Agrawal et al., 2023; Tylutka et al., 2023; Yoshida & Shibata, 2023)

Body muscle composition plays a crucial role in regulating metabolism and fat distribution. Greater muscle mass helps boost metabolism and reduce fat accumulation, including visceral fat. Individuals with low muscle composition have an increased risk of visceral fat buildup, which can lead to health issues such as insulin resistance and chronic inflammation. Research suggests that physical exercise aimed at increasing muscle mass can help reduce visceral fat levels and improve metabolic profiles. (Salih, 2023; Topete et al., 2023; U-Din, 2023)

Body fat composition, particularly total body fat percentage, is closely related to visceral fat accumulation. Individuals with a higher body fat percentage tend to have greater visceral fat deposits. Visceral fat is considered more harmful than subcutaneous fat as it contributes to the increased secretion of inflammatory cytokines involved in atherosclerosis and metabolic dysfunction. Therefore, controlling body fat composition is a key factor in preventing metabolic diseases. (Antonio-Villa et al., 2023; Huang, 2023; U-Din, 2023)

Blood sugar, particularly fasting glucose levels, serves as a key indicator of insulin sensitivity and glucose metabolism. High blood sugar levels often lead to insulin resistance, which triggers increased lipogenesis in the liver and visceral fat accumulation. Visceral fat responds more sensitively to insulin than subcutaneous fat, causing greater fat storage in individuals with insulin resistance. This relationship between high blood sugar levels and visceral fat accumulation worsens metabolic conditions such as type 2 diabetes and metabolic syndrome. (Schleh et al., 2023; Shirakawa & Sano, 2023; Yang et al., 2023)

3. METHODS

This study employs multiple linear regression analysis to investigate the relationship between anthropometric measurements, simple laboratory variables, and visceral fat deposition. The data was taken at St. Assisi Church with a total sample size of 32 respondents. The anthropometric measurement is using OMRON Body Composition Monitor HBF-375 and GEA medical HT721 digital height meter. The simple biochemical test was conducted using Fora 6 plus. The Inclusion criteria is respondents with the age of 60 and above. The exclusion criteria are uncooperative respondents, refusal to conduct the examination, and data incompleteness.

The respondents are required to fill out the questionnaire. After that, respondents will have anthropometric measurement by using the OMRON Body Composition Monitor HBF-375 to measure the weight in kilograms, body mass index (BMI), total arm muscles in percent (%), total trunk muscles in percent (%), and total leg muscles in percent (%), while the GEA medical HT721 digital height meter used to measure the respondents' height in centimeters. The biochemical test containing hemoglobin in mg/dL, and was tested by using Fora 6 plus. Data presentation is in the form of descriptive data presentation (data distribution of intent and proportion) and Spearman correlation analysis. The significance limit used is 5%. This study received ethical permission from Tarumanagara University.

4. RESULTS AND DISCUSSION

The respondent characteristics indicate that all participants are women, with an average age of 72.44 years. The average systolic blood pressure is 125.26 mmHg, and the average diastolic blood pressure is 70.68 mmHg. Hemoglobin levels show an average of 11.05 mg/dL, while hematocrit levels average 33.06%. Blood sugar levels average 109.25 mg/dL, and uric acid levels average 5.61 mg/dL.

Anthropometric measurements reveal an average body weight of 56.30 kg and an average body height of 151.06 cm. The average arm circumference is 27.10 cm, waist circumference is 91.63 cm, and calf circumference is 33.84 cm. The Body Mass Index (BMI) shows an average of 24.94. Body composition analysis highlights an average overall total muscle percentage of 21.52%. Trunk total muscle averages 15.35%, arm total muscle 23.12%, and leg total muscle 34.32%. The body fat percentage averages 36.51%. These results provide insight into the physical and physiological profiles of the respondents. (Table 1)

Table 1. Respondents' Characteristics

Variables	Results
Gender, (%)	
- Women	32 (100)
- Men	0 (0)
Age, mean (SD) years	72.44 (6.83)
Systolic blood pressure, mean (SD) mmHg	125.26 (11.41)
Diastolic blood pressure, mean (SD) mmHg	70.68 (8.82)
Hemoglobin, mean (SD) mg/dL	11.05 (1.87)
Hematocrit, mean (SD) %	33.06 (5.56)
Blood sugar, mean (SD) mg/dL	109.25 (42.39)
Uric acid, mean (SD) mg/dL	5.61 (1.38)
Body weight, mean (SD) kg	56.30 (13.66)
Body height, mean (SD) cm	151.06 (4.53)
Arm circumference, mean (SD) cm	27.10 (4.28)
Waist circumference, mean (SD) cm	91.63 (12.05)
Calf circumference, mean (SD) cm	33.84 (6.35)
Body Mass Index, mean (SD)	24.94 (5.93)
Overall total muscle, mean (SD) %	21.52 (2.19)
Trunk total muscle, mean (SD) %	15.35 (1.94)
Arm total muscle, mean (SD) %	23.12 (4.06)
Leg total muscle, mean (SD) %	34.32 (1.98)
Body fat, mean (SD) %	36.51 (5.72)

The Spearman correlation analysis highlights significant relationships between several variables and visceral fat levels. Diastolic blood pressure shows a significant positive correlation with visceral fat ($p = 0.004$), emphasizing its potential link to fat deposition. Uric acid also demonstrates a significant positive relationship ($p = 0.001$), suggesting its involvement in visceral fat accumulation.

Body weight ($p = 0.000$), arm circumference ($p = 0.000$), waist circumference ($p = 0.000$), calf circumference ($p = 0.000$), BMI ($p = 0.000$), and body fat ($p = 0.000$) all exhibit strong positive associations with visceral fat, underscoring their roles as key contributors. Conversely, overall total muscle ($p = 0.014$), trunk total muscle (p-value = 0.000), and arm total muscle (*p* = 0.000) display significant negative correlations, suggesting that increased muscle mass in these regions may mitigate visceral fat levels.

Other variables, including age (*p* = 0.091), systolic blood pressure (*p* = 0.091), hemoglobin (*p* = 0.286), hematocrit (*p* = 0.511), blood sugar (*p* = 0.252), body height (*p* = 0.673), and leg total muscle (*p* = 0.342), do not show statistically significant relationships with visceral fat, indicating no meaningful association in this study. (Table 2)

Table 2. Parameters Correlation with Visceral Fat

Variables	**Visceral Fat**	
	Correlation-r	**P-value**
Age	-0.303	0.091
Systolic blood pressure	0.289	0.091
Diastolic blood pressure	0.507	0.004
Hemoglobin	0.195	0.286
Hematocrit	0.121	0.511
Blood sugar	0.209	0.252
Uric acid	0.555	0.001
Body weight	0.942	0.000
Body Height	-0.078	0.673
Arm circumference	0.951	0.000
Waist circumference	0.863	0.000
Calf circumference	0.684	0.000
BMI	0.994	0.000
Overall Total Muscle	-0.430	0.014
Trunk total muscle	-0.781	0.000
Arm total muscle	-0.953	0.000
Leg total muscle	0.173	0.342
Body fat	0.889	0.000

The multiple linear regression analysis reveals several significant predictors of the dependent variable. Hemoglobin demonstrates a significant negative relationship (*p* = 0.003), indicating its inverse association with the outcome. Body weight emerges as a strong positive predictor (*p* = 0.000), highlighting its substantial influence. Conversely, body height shows a significant negative association (*p* = 0.000), suggesting a notable inverse impact. Similarly, body fat significantly predicts the outcome with a negative relationship (*p* = 0.000), indicating its adverse effect. Lastly, arm total muscle exhibits a strong negative association (*p* = 0.000), emphasizing its critical role as a determinant. These findings collectively provide valuable insights into the factors influencing the dependent variable. (Table 3)

Table 3. Multiple Linear Regression of Parameters to Visceral Fat

	Model	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
	(Constant)	87.554	14.066		6.225	0.000
	Age	-0.044	0.049	-0.047	-0.901	0.383
	Systolic blood pressure	0.011	0.025	0.020	0.442	.665
	Diastolic blood pressure	0.004	0.037	0.006	0.116	0.909
	Hemoglobin	-0.138	0.097	-0.040	-1.420	0.177
	Blood Sugar	-0.005	0.005	-0.033	-1.017	0.327
	Uric Acid	-0.221	0.175	-0.047	-1.264	0.227
	Body weight	0.177	0.186	0.374	0.950	0.358
	Body height	-0.165	0.130	-0.117	-1.271	0.224
	Arm circumference	0.030	0.123	0.020	0.243	0.811
	Waist circumference	0.032	0.031	0.059	1.014	0.328
	Calf circumference	-0.022	0.046	-0.022	-0.479	0.639
	Body fat	-0.821	0.221	-0.735	-3.719	0.002
	Overall total muscle	0.221	0.135	0.076	1.630	0.125
	Trunk total muscle	-1.115	1.123	-0.339	-0.993	0.337
	Arm total muscle	-1.562	0.644	-0.991	-2.425	0.029
	Leg total muscle	0.506	0.595	0.156	0.851	0.409
	(Constant)	89.699	6.886		13.026	0.000
	Hemoglobin	-0.204	0.062	-0.059	-3.274	0.003
	Body weight	0.342	0.031	0.723	11.166	0.000
	Body height	-0.317	0.040	-0.224	-7.920	0.000
	Bdoy fat	-0.580	0.091	-0.520	-6.406	0.000
	Arm total muscle	-1.208	0.195	-0.767	-6.182	0.000

The results of the multiple linear regression analysis highlight several significant predictors of the dependent variable. Hemoglobin shows a significant negative association, suggesting that lower hemoglobin levels may influence the outcome variable through reduced oxygen transport capacity. (Urbatsch, n.d.) Hemoglobin is a critical component in delivering oxygen to tissues, and its deficiency may impair cellular energy metabolism, tissue repair, and overall physiological resilience. (Wijaya & Sari Mariyati Dewi Nataprawira, 2024; Plock et al., 2009) This finding aligns with previous studies that associate anemia with compromised functional capacity and increased risk of adverse health outcomes in elderly populations. (Rhodes et al., 2022)

Body weight demonstrates a strong positive association, indicating its substantial influence on the outcome variable. (Chen et al., 2013) This relationship underscores the role of body mass as a determinant of overall physical strength, energy reserves, and metabolic activity. (Wu et al., 2024) Heavier body weight may contribute to improved physical function in certain contexts due to greater muscle mass or energy availability. However, it is essential to interpret this finding within the framework of body composition, as excessive fat mass rather than lean mass could have differing implications. (Leopold, 2024)

Body height exhibits a significant negative association, reflecting its complex interplay with other anthropometric parameters. Taller individuals may have different body proportions or biomechanical challenges that influence the dependent variable. (Matthes & Staub, 2023) This observation aligns with studies suggesting that height can act as a proxy for developmental factors, such as nutrition and health during growth phases, which could affect long-term functional outcomes. (Chmielewski, 2024)

Body fat shows a significant negative association, highlighting its detrimental role in influencing the outcome variable. Excess body fat is associated with systemic inflammation, insulin resistance, and impaired physical performance, which may collectively hinder optimal function. (Böckerman et al., 2014; Murbawani et al., 2021) These findings align with research linking higher fat mass to poorer health outcomes, especially in aging populations where maintaining lean mass is critical for preserving mobility and strength. (Giovannini et al., 2019)

Arm total muscle exhibits the strongest negative association among all variables. This finding underscores the critical importance of skeletal muscle mass in maintaining functional ability. Reduced arm muscle mass may directly impair physical strength, mobility, and the ability to perform daily activities. (Kim et al., 2020; Zhou et al., 2023) The relationship also reflects the broader role of sarcopenia, condition of age related muscle loss on health outcomes. (Prado et al., 2022) This finding is consistent with evidence demonstrating the protective role of skeletal muscle in mitigating frailty, metabolic disorders, and chronic diseases in older adults. (Bruyère et al., 2016)

5. CONCLUSION

This study identifies hemoglobin, body weight, body height, body fat, and arm total muscle as significant predictors of the dependent variable. Hemoglobin shows a negative association, indicating that lower levels may impair oxygen transport and tissue repair. Body weight positively influences the outcome, reflecting its role in providing energy reserves and physical strength. In contrast, body height negatively correlates, suggesting its complex relationship with developmental and biomechanical factors. Body fat demonstrates a detrimental effect, likely due to its association with inflammation and reduced physical performance. Arm total muscle emerges as the strongest predictor, highlighting the critical role of skeletal muscle mass in maintaining strength, mobility, and functional capacity.

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