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Korelasi antara Pengukuran Antropometri dan Pengukuran Kaliper Lemak dengan Rasio Trigliserida dan Tekanan Darah

Correlation between Anthropometry and Fat Caliper Measurements with Triglyceride Ratios and Blood Pressure

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Kata Kunci :
Antropometri; Kaliper lemak; Rasio trigliserida; Tekanan darah

ABSTRAK

Pendahuluan: Pengukuran antropometri, seperti penggunaan kaliper lemak dan lingkar tubuh, memberikan gambaran non-invasif mengenai distribusi lemak dan total adipositas, yang keduanya merupakan indikator penting status kesehatan. Peningkatan lemak viseral meningkatkan risiko kardiovaskular melalui mekanisme disfungsi metabolik. Rasio trigliserida terhadap HDL (TG/HDL-C) merupakan prediktor kuat risiko kardiovaskular karena berkaitan erat dengan inflamasi sistemik, dislipidemia, dan resistensi insulin. Adipositas berlebih juga berkontribusi terhadap peningkatan tekanan darah melalui gangguan metabolisme lipid dan fungsi vaskular. Penelitian ini bertujuan untuk mengetahui korelasi antara pengukuran antropometri (lingkar betis, leher, lengan atas, dan pinggang), berat badan, indeks massa tubuh (IMT), serta kaliper lemak dengan rasio trigliserida/HDL dan tekanan darah.**Metode:** Penelitian potong lintang ini dilakukan di Kelurahan Krendang, Tambora, Jakarta Barat pada bulan November 2024 dan melibatkan peserta berusia ≥18 tahun. Partisipan yang menggunakan obat antihipertensi atau penurun kolesterol, serta yang menolak pengambilan sampel darah atau pemeriksaan fisik, dikecualikan. Pengukuran meliputi tebal lipatan kulit di empat titik, berbagai parameter antropometri, tekanan darah, serta pengambilan darah vena untuk analisis kadar HDL, trigliserida, dan perhitungan rasio keduanya. Analisis statistik menggunakan uji Korelasi Spearman, dengan fokus utama pada rasio trigliserida/HDL.**Hasil:** Analisis multivariat menunjukkan bahwa lingkar pinggang merupakan prediktor terkuat terhadap rasio trigliserida/HDL. Lingkar panggul dan lingkar betis diidentifikasi sebagai indikator penting dalam memprediksi tekanan darah sistolik dan diastolik, sedangkan kaliper lemak suprailiaka dan skapula secara khusus berkorelasi dengan tekanan darah diastolik.
Kesimpulan: Lingkar pinggang, bersama dengan beberapa pengukuran antropometri dan kaliper lemak tertentu, merupakan prediktor yang bernilai untuk risiko kardiovaskular dan metabolik, sehingga berperan penting dalam penilaian risiko dini.

Keywords :
Anthropometry; Blood pressure; Fat caliper; Triglycerides ratio

ABSTRACT

Introduction: *Anthropometric measurements, such as fat calipers and circumference, offer non-invasive insights into fat distribution and total adiposity, both crucial health markers. Increased visceral fat heightens cardiovascular risk by driving metabolic dysfunction. The TG/HDL-C ratio serves as a strong predictor of cardiovascular risk, linking systemic inflammation, dyslipidemia, and insulin resistance. Excess* *adiposity also elevates blood pressure by impairing lipid metabolism and vascular function. This study aims to see the correlation between anthropometry measurement (calf, neck, upper arm, and waist circumferences), body weight, body mass index and fat caliper with the triglyceride/HDL ratio and blood pressure.* ***Methods:*** *This cross-sectional study, conducted in Krendang Village in November 2024, included participants aged 18 years or older, excluding those using antihypertensive or cholesterol-lowering medications or unwilling to provide blood samples or undergo physical exams. Measurements included skinfold thickness at four sites, various anthropometric parameters, blood pressure, and venous blood samples analyzed for HDL, triglycerides, and their ratio. Statistical analysis utilized Spearman Correlation, focusing on the triglyceride/HDL ratio* ***Results:*** *Multivariate analysis revealed that waist circumference is the strongest predictor of the triglyceride/HDL ratio. Hip circumference and calf circumference were identified as key indicators for predicting both systolic and diastolic blood pressure, while suprailiac fat caliper and scapular fat caliper were specifically associated with predicting diastolic blood pressure.****Conclusion:*** *Waist circumference, along with select anthropometric and fat caliper measurements, serves as valuable predictors for cardiovascular and metabolic risk factors, emphasizing their importance in early risk assessment.*

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INTRODUCTION

Anthropometric measurements, including fat caliper assessments and circumference, serve as essential methods for evaluating body composition. These non-invasive techniques effectively measure fat distribution and total adiposity, both crucial indicators of overall health. Studies regularly reveal that extra fat, especially visceral adipose tissue causes metabolic abnormalities and raises cardiovascular disease risk.[1] Though anthropometric methods have great value, further study is required to find how these measurements correlate with important markers of metabolic and cardiovascular health, such lipid profiles and blood pressure. Finding the reasons behind negative health results and directing preventative actions could help by means of establishing these relationships.[2]

Maintaining general health depends on lipid metabolism, so disturbance often shows up early in metabolic illnesses. Among measures associated to lipid metabolism, the TG/HDL-C ratio has become a consistent indicator of cardiovascular risk and metabolic syndrome.[3] Systemic inflammation, atherogenic dyslipidemia, and insulin resistance are intimately related to raised TG/HDL-C ratios. These metabolic anomalies not only increase the risk of hypertension but also aggravate the stress on vascular function, which helps to gradually deteriorate cardiovascular condition.[4]

A major gauge of cardiovascular health, blood pressure has complicated relationships with body composition and lipid metabolism. Particularly in central fat stores, higher adiposity exerts mechanical and metabolic effects that raise blood pressure.[5] Excess adipose tissue alters lipid profiles, causes systemic inflammation, and increases sympathetic nervous system activity, therefore adding to vascular resistance. Knowing how blood pressure, triglyceride ratios, and anthropometric parameters interact could help one to better understand the complicated processes behind metabolic and cardiovascular diseases.[6]

Anthropometric data, fat caliper measurements, cholesterol indicators, and blood pressure readings taken together offer a more complete approach to assess cardiovascular risk.[7] Research on the cumulative predictive value of these links remains scant even as their importance is becoming more known. Examining these links in various groups will assist us to better grasp how metabolic and cardiovascular health effects are influenced by body composition characteristics.[8]

This study aims to see the correlation between anthropometry (calf, neck, upper arm, and waist circumferences), body weight, body mass index and fat caliper with the triglyceride/HDL ratio and blood pressure.

METHOD

This cross-sectional study was conducted in Krendang Village in November 2024. Participants were eligible if they were at least 18 years old and willing to participate. Exclusion criteria included refusal to provide blood samples or undergo physical examination, the use of antihypertensive medication, or cholesterol-lowering drugs.

Respondents completed a questionnaire covering demographic information, lifestyle habits, and medical history. Skinfold thickness was measured at four anatomical sites on the right side of the body—biceps, triceps, suprailiac, and subscapular. To measure subcutaneous fat using a fat caliper, pinch a fold of skin at specific body sites, place the caliper jaws around the fold, apply consistent pressure, and record the measurement in millimeters. Each site was measured three times by a certified professional, with the average value recorded to ensure accuracy.

Anthropometric measurements included calf, neck, upper arm, and waist circumferences, all taken with a flexible tape. To measure calf, neck, hip, and right upper arm circumference, wrap a flexible measuring tape around the specific area without compressing the skin. Measure calf circumference at the widest part while standing, neck circumference just below the larynx with the head in a neutral position, hip circumference at the widest point of the hips and buttocks, and right upper arm circumference at the midpoint between the shoulder and elbow while the arm is relaxed. Waist circumference was measured at the midpoint between the lower rib and iliac crest to assess abdominal fat distribution. Weight and height were measured following standard protocols, and Body Mass Index (BMI) was calculated by dividing weight (kg) by height squared (m^2). Blood pressure (systolic and diastolic) was assessed using standardized clinical examination protocols.

Venous blood samples were collected following standard medical procedures to measure HDL, triglycerides, and the triglyceride/HDL ratio using the Nesco Lipid Monitoring System. Statistical analysis focused on the Spearman Correlation, with the triglyceride/HDL ratio and blood pressure as the dependent variable. The ethical review for this study was conducted by Tarumanagara University.

RESULTS

The findings include a complete review of the research participants' anthropometric, biochemical, and cardiovascular profiles. Gender distribution is significantly different ($p < 0.05$). Measurements of waist, hip, arm, neck, and calf circumferences are statistically significant ($p < 0.01$), indicating differences in body composition across the group.

Body fat caliper evaluations of biceps, triceps, suprailiac, and scapular fat show significant results ($p < 0.01$), demonstrating changes in fat distribution. BMI has a substantial relationship with body composition ($p < 0.01$). The triglyceride-to-HDL ratio, an important metabolic measure, is significantly higher ($p < 0.05$). Significant variances in systolic and diastolic blood pressure measures ($p < 0.01$) suggest cardiovascular implications for the community. These *p*-values increase the reliability and significance of the findings. (Table1)

Tabel 1. Respondents' Characteristics

Variables	Results
Gender:	
- Women (%)	108 (90.8)
- Men (%)	11 (9.2)
Waist circumference, mean (SD) cm	84.31 (11.04)
Hip circumference, mean (SD) cm	98.43 (10.06)
Arm circumference, mean (SD) cm	28.91 (4.06)
Neck circumference, mean (SD) cm	33.84 (4.25)
Calf circumference, mean (SD) cm	35.79 (3.99)
Bicep fat caliper, mean (SD) mm	6.11 (4.61)
Triceps fat caliper, mean (SD) mm	15.96 (5.26)
Suprailiac fat caliper, mean (SD) mm	20.74 (7.49)
Scapular fat caliper, mean (SD) mm	15.79 (6.51)
Body Mass Index (BMI)	30.09 (27.16)
Triglyceride/HDL ratio, mean (SD)	4.01 (1.21)
Systolic blood pressure, mean (SD) mmHg	132.08 (22.24)
Diastolic blood pressure, mean (SD) mmHg	83.47 (13.52)

The study found strong connections between the triglyceride-to-HDL ratio and several anthropometric factors. Waist circumference and hip circumference have a significant connection ($p < 0.001$) with positive correlation for both waist circumference (r = 0.368) and hip circumference (0.317). Significant relationships were found between arm circumference (r = 0.295; $p = 0.001$), neck circumference (r = 0.273; $p = 0.003$), and calf circumference (r = 0.298; $p < 0.001$), indicating a link between these measurements and metabolic risk.

There are significant associations between fat caliper measurements at the suprailiac (r = 0.296; $p = 0.001$) and scapular sites (r = 0.316; $p < 0.001$), as well as the triceps site (p = 0.038). However, the bicep location does not reach statistical significance (r = 0.159; p = 0.085), demonstrating variation in fat distribution patterns. BMI significantly corresponds with the triglyceride-to-HDL ratio (r = 0.344; $p < 0.001$), indicating its importance as a metabolic indicator. (Table 2)

Tabel 2. Spearman Correlation between Anthropometric and Fat Caliper Measurement with Triglyceride/HDL ratio

Parameter	Triglyceride/ HDL ratio	
N =119 respondents	r-correlation (Spearman)	*p*-value
Waist circumference	0,368	<0,001**
Hip circumference	0,317	<0,001**
Arm circumference	0,295	0,001**
Neck circumference	0,273	0,003**
Calf circumference	0,298	<0,001**
Biceps Fat Caliper	0,159	0,085
Triceps Fat Caliper	0,190	0,038*
Suprailiac Fat Caliper	0,296	0,001**
Fat Caliper Scapular	0,316	<0,001**
Body mass index (BMI)	0,344	<0,001**

***, Correlation is significant at the 0.01 level (2-tailed)*
**, Correlation is significant at the 0.05 level (2-tailed)*

The study found significant relationships between anthropometric measurements and blood pressure indicators. Waist circumference has significant associaiton with both systolic (*p*-value = 0.046) and diastolic blood pressure (p-value = 0.029). Hip circumference is significantly associated with systolic blood pressure (p = 0.013), but not with diastolic blood pressure (p = 0.063).

Arm circumference (*p* = 0.375 for systolic, *p* = 0.148 for diastolic) and neck circumference (*p* = 0.884 for systolic, *p* = 0.474 for diastolic) have no significant link with blood pressure. Similarly, calf circumference has no significant association with systolic (*p* = 0.582) and diastolic (*p* = 0.798) blood pressures.

No fat caliper measurements show statistically significant relationships with blood pressure parameters, with p-values consistently greater than 0.05. BMI, on the other hand, correlates significantly with systolic blood pressure (*p* = 0.031), highlighting its importance in hypertension risk, but its correlation with diastolic blood pressure approaches significance (*p* = 0.057). (Table 3)

Tabel 3. Spearman Correlation between Anthropometric and Fat Caliper Measurement with Systolic and Diastolic Blood Pressure

Parameter	Systolic blood pressure		Diastolic blood pressure	
N =119 responden	r-correlation (Spearman)	*p*-value	r-correlation (Spearman)	*p*-value
Waist circumference	0,183	0,046*	0,200	0,029*
Hip circumference	0,227	0,013*	0,171	0,063
Arm circumference	0,082	0,375	0,133	0,148
Neck circumference	0,014	0,884	0,066	0,474
Calf circumference	-0,051	0,582	0,024	0,798
Biceps Fat Caliper	0,091	0,325	0,125	0,176
Triceps Fat Caliper	0,032	0,728	-0,042	0,648
Suprailiac Fat Caliper	0,049	0,593	0,036	0,699
Fat Caliper Scapular	0,057	0,537	0,147	0,110
Body mass index (BMI)	0,197	0,031*	0,175	0,057

***, Correlation is significant at the 0.01 level (2-tailed)*
**, Correlation is significant at the 0.05 level (2-tailed)*

Multiple linear regression analysis finds significant predictors of the dependent variable. Waist circumference is a significant predictor (*p* = 0.014), indicating a considerable contribution to the model. However, the scapular fat caliper fails to attain statistical significance (*p* = 0.094), implying that it may not predict the outcome independently in this situation. These results emphasize the significance of waist circumference in explaining the variability of the dependent variable. (Table 4)

Table 4. Multiple Linear Regression of Anthropometric and Fat Caliper with Triglyceride/HDL ratio

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-0.618	1.370		-0.451	0.653
	Waist circumference	0.019	0.020	0.176	0.985	0.327
	Hip circumference	0.001	0.019	0.007	0.041	0.967
	Arm circumference	0.004	0.046	0.013	0.083	0.934
	Neck circumference	0.037	0.032	0.130	1.162	0.248
	Calf circumference	0.041	0.039	0.134	1.052	0.295
	Biceps fat caliper	0.028	0.025	0.105	1.116	0.267
	Suprailiac fat caliper	-0.012	0.023	-0.072	-0.512	0.609
	BMI	0.000	0.004	0.009	0.094	0.925
	Scapular fat caliper	0.035	0.026	0.187	1.348	0.181
	Triceps fat caliper	-0.024	0.025	-0.106	-0.962	0.338
9	(Constant)	0.944	0.850		1.111	0.269
	Waist circumference	0.030	0.012	0.273	2.504	0.014
	Scapular fat caliper	0.034	0.020	0.184	1.691	0.094

a. Dependent Variable: TG/HDL ratio

Multiple linear regression analysis finds significant predictors of systolic blood pressure the dependent variable. Hip circumference has a significant positive correlation with the result (Beta = 0.469; *p* = 0.000), showing that it contributes significantly to the model. Calf circumference, on the other hand, has a significant negative correlation with the dependent variable (Beta = -0.338; *p* = 0.001), indicating that it has the opposite effect on the result. These findings emphasize the distinct contributions of hip and calf circumferences in predicting the dependent variable. (Table 5)

Table 5. Multiple Linear Regression of Anthropometric and Fat Caliper with Systolic Blood Pressure

		B	Model	Unstandardized Coefficients		Sig.
1	(Constant)	97.972	25.025		3.915	0.000
	Waist circumference	0.343	0.358	0.171	0.958	0.340
	Hip circumference	0.983	0.349	0.445	2.815	0.006
	Arm circumference	0.766	0.846	0.140	0.906	0.367
	Neck circumference	-0.702	0.583	-0.134	-1.204	0.231
	Calf circumference	-2.090	0.709	-0.375	-2.949	0.004
	Biceps fat caliper	0.165	0.451	0.034	0.365	0.716
	Suprailiac fat caliper	-0.485	0.416	-0.163	-1.165	0.247
	BMI	-0.066	0.075	-0.080	-0.882	0.380
	Scapular fat caliper	0.438	0.473	0.128	0.926	0.356
	Triceps fat caliper	-0.696	0.465	-0.165	-1.498	0.137
9	(Constant)	97.456	20.321		4.796	0.000
	Hip circumference	1.037	0.224	0.469	4.640	0.000
	Calf circumference	-1.885	0.563	-0.338	-3.346	0.001

a. Dependent Variable: Systolic blood pressure

Multiple linear regression analysis identifies important predictors of diastolic blood pressure. Hip circumference has a positive and significant association with the result (Beta = 0.349; p = 0.004), showing that it makes an important contribution to the model. Calf circumference, on the other hand, has a significant negative correlation with the dependent variable (Beta = -0.227; p = 0.039).

Similarly, the suprailiac fat caliper has a significant negative correlation with the result (Beta = -0.290; *p* = 0.037), whereas the scapular fat caliper has a significant positive contribution to the model (Beta = 0.294; *p* = 0.025). These findings show the interaction of multiple anthropometric and fat distribution variables in predicting the dependent variable, revealing both positive and negative relationships. (Table 6)

Table 6. Multiple Linear Regression of Anthropometric and Fat Caliper with Diastolic Blood Pressure

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	67.287	15.708		4.283	0.000
	Waist circumference	0.187	0.225	0.153	0.831	0.408
	Hip circumference	0.368	0.219	0.274	1.678	0.096
	Arm circumference	0.717	0.531	0.215	1.351	0.179
	Neck circumference	-0.289	0.366	-0.091	-0.791	0.431
	Calf circumference	-1.038	0.445	-0.307	-2.334	0.021
	Biceps fat caliper	0.176	0.283	0.060	0.622	0.535
	Suprailiac fat caliper	-0.435	0.261	-0.241	-1.665	0.099
	BMI	-0.033	0.047	-0.067	-0.714	0.477

	Scapular fat caliper	0.507	0.297	0.244	1.707	0.091
	Triceps fat caliper	-0.541	0.292	-0.210	-1.852	0.067
7	(Constant)	66.120	14.292		4.626	0.000
	Hip circumference	0.469	0.158	0.349	2.960	0.004
	Calf circumference	-0.770	0.369	-0.227	-2.087	0.039
	Suprailiac fat caliper	-0.524	0.248	-0.290	-2.115	0.037
	Scapular fat caliper	0.610	0.270	0.294	2.264	0.025

a. Dependent Variable: Diastolic blood pressure

The multiple linear regression study looks at determinants of the triglyceride to HDL (TG/HDL) ratio, which is an important sign of metabolic health. The findings highlight the importance of waist circumference as a key predictor, lending support to previous notions that central adiposity is substantially associated with metabolic dysregulation, such as dyslipidemia and insulin resistance. This is consistent with data showing visceral fat relates to elevated triglyceride levels and lower HDL cholesterol.

The triglyceride to HDL (TG/HDL) ratio is an important measure of metabolic health and cardiovascular risk because it represents the balance of atherogenic (triglycerides) and protective lipids (HDL cholesterol).[9] High TG/HDL ratios are frequently related with metabolic syndrome, insulin resistance, and an increased risk of atherosclerosis.[10] Central adiposity, as measured by waist circumference, has emerged as a strong predictor of this ratio, emphasizing the metabolic relevance of visceral fat.[11] Unlike subcutaneous fat, visceral fat is metabolically active and has a significant impact on lipid and glucose metabolism.[3]

Visceral fat distributes free fatty acids and inflammatory mediators directly into the portal circulation, causing a variety of metabolic disturbances.[12] Excess free fatty acids boost hepatic triglyceride synthesis, which promotes the secretion of very-low-density lipoproteins (VLDL) and leads to hypertriglyceridemia.[13] Concurrently, increased triglycerides promote the exchange of triglycerides for cholesterol esters in HDL particles, which is facilitated by cholesteryl ester transfer protein (CETP). This exchange generates triglyceride-enriched HDL, which is unstable and quickly removed from circulation, resulting in reduced HDL cholesterol levels. Furthermore, central obesity exacerbates insulin resistance by reducing lipoprotein lipase function and causing additional lipid imbalance.[14]

Inflammatory cytokines and altered adipokine production from visceral fat contribute to chronic low-grade inflammation, which exacerbates insulin resistance and lipid abnormalities.[15] These processes demonstrate the mechanistic linkages between central adiposity and the TG/HDL ratio.[16] Clinically, the TG/HDL ratio is a useful biomarker for measuring metabolic risk, while waist circumference is a straightforward tool for estimating visceral fat and predicting lipid abnormalities.[17]

Other anthropometric measurements, such as hip, arm, neck, and calf circumferences, reveal no significant relationship with the TG/HDL ratio.[18] These findings show that peripheral fat distribution may have a lower direct influence on metabolic risk than central adiposity.[19] Similarly, body fat caliper measurements, including biceps, triceps, suprailiac, and scapular fat, do not significantly predict the TG/HDL ratio, showing that distinct fat depots have varying metabolic influences.[20]

The multiple linear regression analysis identifies significant predictors of systolic blood pressure, highlighting the intricate interaction of anthropometric and adiposity-related parameters. Hip circumference is a strong predictor, supporting the idea that peripheral adiposity has a specific physiological impact on blood pressure regulation. This finding is consistent with previous research indicating that fat distribution in the hip region may alter vascular compliance or hormonal pathways that control blood pressure.[21]

The finding of hip circumference as a major systolic blood pressure predictor emphasizes the part peripheral obesity plays in cardiovascular control.[22] Unlike central adiposity, which is sometimes linked with unfavorable metabolic consequences, fat distribution in the hip area may give some protective or unique physiological advantages. Studies show that enhanced lipid profiles and insulin sensitivity, which would indirectly affect blood pressure control are linked to peripheral adiposity, particularly in the hips and thighs.[23]

Vascular mechanics can also help to clarify the link between hip circumference and blood pressure.[24] Hip fat deposits could improve vascular compliance, thereby lowering resistance in peripheral blood arteries and so lowering blood pressure.[25] Furthermore, the different between central and peripheral fat stores are hormonal elements including the action of adipokines such as leptin and adiponectin.[24] More plentiful in subcutaneous fat, adiponectin has anti-inflammatory and vasodilatory effects that might lower blood pressure.[26]

On the other hand, calf circumference shows a negative correlation with systolic blood pressure, therefore stressing the possible preventive power of muscle mass or peripheral fat distribution. This association could reflect the different metabolic or hemodynamic effects of lower limb adiposity relative to central adiposity. In those with smaller calf circumferences, reduced muscle mass or changed peripheral vascular dynamics could help to explain increased systolic blood pressure.[27,28]

The negative correlation between systolic blood pressure and calf circumference emphasizes the complex function of peripheral muscular mass and fat distribution in cardiovascular control. As shown by calf circumference, peripheral adiposity and muscle mass in the lower extremities may have protective effects unlike central adiposity, which is highly correlated with negative cardiovascular outcomes.[27,28]

One theory lies in the metabolic activity of skeletal muscle. Greater glucose absorption, better insulin sensitivity, and higher metabolic efficiency are linked to larger muscular mass in the calves.[29] By lowering systemic inflammation and enhancing vascular function, these elements can indirectly affect blood pressure. Additionally serving as a reservoir for glucose and fatty acid metabolism, skeletal muscle helps to reduce the metabolic abnormalities usually connected with hypertension.[30]

Other possible cause is peripheral vascular dynamics Greater calf circumference could imply stronger lower limb microcirculation and improved vascular compliance.[31] Lowering of peripheral resistance and lower systolic blood pressure could follow from this better vascular health. On the other hand, lower calf circumference often a sign of sarcopenia or decreased muscle mass may cause poorer blood flow, more arterial stiffness, and higher blood pressure.[32]

Additionally, linked to physical inactivity and systemic metabolic drop, both of which are risk factors for hypertension are reduced muscle mass in the calves.[33] In older populations, when diminishing physical activity and muscle atrophy (sarcopenia) raise cardiovascular risk, this link might be especially crucial.[34,35]

Interestingly, other factors, such as waist circumference and body mass index (BMI), did not have significant relationships in the final model.[36] This shows that, whereas central adiposity and overall body size are important in larger metabolic and cardiovascular contexts, they may not drive systolic blood pressure fluctuation alone when other parameters such as hip and calf circumferences are taken into account.[37]

The lack of relevance for other variables, such as biceps and triceps fat calipers and scapular fat, may imply that subcutaneous fat thickness in these locations has little direct impact on systolic blood pressure. This supports the growing understanding that visceral and central fat, rather than peripheral subcutaneous fat, are more important predictors of hypertension and other cardiovascular problems.[38]

Significant determinants of diastolic blood pressure are revealed by multiple linear regression analysis, therefore clarifying the interaction between fat caliper and anthropometric measurements. One interesting predictor is hip circumference, which suggests that differences in blood pressure may result from peripheral fat distribution influencing vascular dynamics.[39] This result is consistent with data showing that fat accumulated in the hips and thighs may have a different metabolic and hemodynamic effect than central fat, thereby maybe affecting the diastolic function and systemic vascular resistance.[40]

The relationship between hip circumference and diastolic blood pressure emphasizes the physiological relevance of fat distribution in the peripheral parts of the body.[39] Whereas central adiposity has negative effects, peripheral fat, especially around the hips and thighs which may have a beneficial metabolic and cardiovascular role. Different hormonal and circulatory effects of peripheral fat help to explain this variation.[41]

Less metabolically active than visceral fat, adipose tissue found in the hip and thigh areas is mostly subcutaneous. Key players in insulin resistance and systemic inflammation, free fatty acids and pro-inflammatory cytokines are known to be released in lower levels by subcutaneous fat.[40] This decreased inflammatory activity could help to improve vascular function and lower systemic vascular resistance, therefore perhaps producing more favorable diastolic blood pressure readings.[39]

Furthermore, altered blood flow dynamics and vascular compliance may result from fat distribution in the hips and thighs. More elastic and sensitive vascular walls made possible by peripheral fat deposition would let blood flow and arterial stiffness to be lowered. By reducing resistance during the heart's relaxation phase, this better vascular health can aid to sustain ideal diastolic blood pressure.[42]

Other important factor is the hormonal channels connected to the distribution of peripheral fat.[43] More active in encouraging fat storage in the hip and thigh regions, estrogen has vasodilatory effects and can so enhance vascular health. [44] This hormonal influence can help to partially explain why persons with higher hip circumference usually have better cardiovascular profiles than those with mostly central fat distribution.[45]

On the other hand, calf circumference shows a negative correlation with diastolic blood pressure, therefore emphasizing the possible protective function of either peripheral fat distribution or lower-limb muscle mass. Reduced calf circumference could indicate sarcopenia, disorders linked to poor vascular function and elevated arterial stiffness, or reduced muscle mass. This association stresses the need of preserving lower limb muscle mass as a possible blood pressure control mechanism.[27]

The possible preventive action of peripheral muscle mass and fat distribution in cardiovascular health is shown by the negative connection between calf circumference and diastolic blood pressure. Emphasizing how body composition affects vascular function and blood pressure control, this relationship underlines the importance of the lower limbs as major locations for metabolic and hemodynamic control.[46]

Lower limb muscle mass is sometimes approximated by calf circumference. Usually reflecting more muscular bulk, a larger calf circumference is related with better blood flow.[47] Promoting better glucose and lipid metabolism, muscle tissue is metabolically active and helps to lower systemic inflammation and improve endothelial function.[48] These physiological effects help to minimize arterial stiffness and increase vascular flexibility, hence reducing diastolic blood pressure.[49] On the other hand, smaller calf circumference could point to sarcopenia, a disorder marked by decreased muscle mass and strength. Because of systemic inflammation, reduced physical activity, and lower production of muscle-derived hormones (myokines) that maintain vascular health, sarcopenia is associated with impaired vascular function and increased arterial stiffness.[50]

Calf circumference, which measures peripheral fat distribution, may also help regulate blood pressure. Fat accumulated in the calves and other peripheral areas is typically subcutaneous which is less dangerous than visceral fat. This type of fat distribution may contribute to improved vascular compliance and a lower risk of arterial stiffness, which helps regulate diastolic blood pressure.[47]

The suprailiac fat caliper also adversely correlates with diastolic blood pressure, showing that adiposity in this location may particularly impair cardiovascular control. This link could reflect the metabolic activity of subcutaneous fat in the suprailiac area, which might differ from visceral fat in its impact on systemic inflammation, insulin[51]

The observed negative connection between the suprailiac fat caliper and diastolic blood pressure demonstrates the complex interaction between regional adiposity and cardiovascular health. Adiposity in the suprailiac area, which predominantly reflects subcutaneous fat storage, appears to have distinct effects on vascular and metabolic dynamics, thereby compromising blood pressure management.[52]

Subcutaneous fat in the suprailiac area is metabolically active and participates in overall metabolic processes.[53] Excess fat in this location can cause systemic inflammation by secreting pro-inflammatory cytokines, which impair endothelial function and vascular tone.[54] Chronic inflammation causes increased arterial stiffness and decreased vasodilation, which can raise diastolic blood pressure. Furthermore, this subcutaneous fat depot may impair insulin sensitivity, with decreased insulin action leading to vascular dysfunction via processes such as increased sympathetic nervous system activity and salt retention.[55]

The suprailiac fat caliper's influence may differ from that of visceral fat, which is more strongly associated with negative cardiometabolic outcomes. While visceral fat has a direct impact on portal circulation and liver metabolism, suprailiac subcutaneous fat may largely influence systemic variables such peripheral vascular resistance. These discrepancies highlight the complexity of fat tissue types and their different functions in cardiovascular risk.[56]

Furthermore, the scapular fat caliper correlates positively with diastolic blood pressure, highlighting the complicated implications of regional fat distribution. Adiposity in the scapular area may interact with systemic metabolic processes, increasing vascular resistance and contributing to greater diastolic pressure.[57]

The positive link between the scapular fat caliper and diastolic blood pressure highlights the complex relationship between regional fat distribution and cardiovascular health. Adiposity in the scapular area, a measure of subcutaneous fat in the upper back, appears to lead to higher vascular resistance, which affects diastolic pressure. This finding explain on how particular fat depots may influence systemic vascular and metabolic processes differently.[58]

Subcutaneous fat in the scapular area may be metabolically active, contributing to systemic inflammatory reactions by secreting adipokines and proinflammatory cytokines.[59] Chronic low-grade inflammation can compromise endothelial function, limiting blood vessel dilation, increasing vascular resistance, and raising diastolic blood pressure. Furthermore, adipose tissue in this region may alter hormonal pathways such as leptin and adiponectin, which regulate vascular tone and metabolism.[60]

The link between scapular fat and diastolic blood pressure highlights the broader implications of regional fat as a cardiovascular risk factor. Unlike visceral fat, which is more directly connected to metabolic problems including insulin resistance and dyslipidemia, scapular fat may exercise its effects via systemic pathways that influence vascular health.[60] Localized buildup of subcutaneous fat may indicate a larger total adiposity burden, which is related with hemodynamic abnormalities such as increased peripheral vascular resistance and changes in cardiac output.[59]

CONCLUSION

This study shows the complex link between body composition, fat distribution, and cardiovascular indicators. The TG/HDL ratio is a key metabolic health measure, and central adiposity, particularly waist circumference, is a predictor. Metabolic activity in visceral fat causes lipid imbalance and insulin resistance, affecting the TG/HDL ratio. Conversely, hip and calf circumferences reflect peripheral fat distribution, which may protect blood pressure.

Hip circumference may improve systolic and diastolic blood pressure due to peripheral fat metabolic effects and vascular compliance. Greater calf circumference, which indicates muscle mass or peripheral fat, is inversely associated with blood pressure, underlining the relevance of lower limb muscle mass for cardiovascular health.

Caliper-measured regional adiposity also affects blood pressure differently. Scapular fat correlates favorably with diastolic pressure, likely due to systemic inflammation, but suprailiac fat correlates negatively, reflecting the complex involvement of subcutaneous fat in metabolic and vascular dynamics. These findings emphasize the need to understand fat distribution patterns and their metabolic and hemodynamic effects. Identifying anthropometric and adiposity-related variables helps understand cardiovascular and metabolic health mechanisms and guide focused therapies.

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