ORIGINAL

Correlation of Abdominal Wall Fat Index on Ultrasonography with Carotid Intima Media Thickness and Lipid Profile

Correlación del índice de grasa de la pared abdominal en la ecografía con el grosor de la íntima media carotídea y el perfil lipídico

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Received: 19 - IV - 2024
Accepted: 16 - V - 2024

doi: 10.3306/AJHS.2024.39.05.109

Abstract

Introduction and aim: Abdominal fat index (AFI) is a measure of the amount of fat present in the abdominal wall, which can be assessed using ultrasound imaging. Carotid intima media thickness (CIMT) is a measure of the thickness of the innermost layer of the carotid artery, which is indicative of atherosclerosis and cardiovascular risk. Lipid profile refers to the levels of different types of fats, including cholesterol and triglycerides, in the blood. The aim of this study is to investigate and analyze the relationship between AFI and CIMT with a particular focus on exploring the associations with lipid profile. By examining these variables, we seek to enhance our understanding of the potential correlations between abdominal fat distribution, vascular health, and lipid metabolism and determine the potential significance of the abdominal wall fat index as a novel parameter for assessing obesity and predicting the risk of developing atherosclerosis, stroke, and cardiovascular diseases.

Methods: The study employed a prospective cohort design involving 80 participants who met specific eligibility criteria. Ultrasonography was used to measure the AFI and CIMT, along with assessing the lipid profile. These results were subsequently compared to the participants' body mass index (BMI).

Results: The study sample included 80 patients, 63.75% were females, and the other 36.25% were males. The majority fall within the age group between 45-55year, about 22.5% of the patients had smoking history. A noteworthy negative correlation exists between AFI and BMI, while AFI has a statistically significant positive correlation with CIMT as well as serum cholesterol and triglyceride.

Conclusions: AFI measurement using ultrasound presents a valuable alternative to both advanced imaging methods and the collection of anthropometric data. It offers a noninvasive, safe, accurate, reproducible, and cost-effective approach, with the added benefit of avoiding ionizing radiation exposure for patients. Sonographic findings exhibit strong correlations between CIMT and lipid profile, so it may facilitates the direct assessment of cardiovascular and metabolic risk factors.

Key words: Abdominal fat index, Carotid intima media thickness, Lipid profile, Ultrasound.

Resumen

Introduction y objetivos: El índice de grasa abdominal (IGA) es una medida de la cantidad de grasa presente en la pared abdominal, que puede evaluarse mediante ecografía. El grosor de la íntima media carotídea (GIMC) es una medida del grosor de la capa más interna de la arteria carótida, que es indicativa de aterosclerosis y riesgo cardiovascular. El perfil lipídico se refiere a los niveles de diferentes tipos de grasas, incluidos el colesterol y los triglicéridos, en la sangre. El objetivo de este estudio es investigar y analizar la relación entre el IGA y el GIMC, con especial atención a explorar las asociaciones con el perfil lipídico. Al examinar estas variables, pretendemos mejorar nuestra comprensión de las correlaciones potenciales entre la distribución de la grasa abdominal, la salud vascular y el metabolismo lipídico, y determinar la importancia potencial del índice de grasa de la pared abdominal como parámetro novedoso para evaluar la obesidad y predecir el riesgo de desarrollar aterosclerosis, ictus y enfermedades cardiovasculares.

Metodología: El estudio empleó un diseño de cohorte prospectivo con 80 participantes que cumplían criterios de elegibilidad específicos. Se utilizó la ecografía para medir el IGA y el GIMC, junto con la evaluación del perfil lipídico. Estos resultados se compararon posteriormente con el índice de masa corporal (IMC) de los participantes.

Resultados: La muestra del estudio incluía 80 pacientes, de los cuales el 63,75% eran mujeres y el 36,25% restante, varones. La mayoría pertenecía al grupo de edad comprendido entre los 45 y los 55 años, y aproximadamente el 22,5% de los pacientes tenía antecedentes de tabaquismo. Existe una correlación negativa notable entre el IGA y el IMC, mientras que el IGA tiene una correlación positiva estadísticamente significativa con el GIMC, así como con el colesterol y los triglicéridos séricos.

Conclusiones: La medición del IGA mediante ultrasonidos constituye una valiosa alternativa tanto a los métodos avanzados de diagnóstico por imagen como a la recogida de datos antropométricos. Ofrece un enfoque no invasivo, seguro, preciso, reproducible y rentable, con la ventaja añadida de evitar la exposición de los pacientes a la radiación ionizante. Los hallazgos sonográficos muestran fuertes correlaciones entre el GIMC y el perfil lipídico, por lo que puede facilitar la evaluación directa de los factores de riesgo cardiovascular y metabólico.

Palabras clave: Índice de grasa abdominal, Grosor íntima-media carotídeo, Perfil lipídico, Ecografía.

Cite as: Ahmed DMK, Mahmood KA. Correlation of Abdominal Wall Fat Index on Ultrasonography with Carotid Intima Media Thickness and Lipid Profile. *Academic Journal of Health Sciences 2024*; 39 (5):109-115 doi: 10.3306/AJHS.2024.39.05.109

Introduction

Cardiovascular diseases (CVDs) continue to be a major global health concern, representing a leading cause of morbidity and mortality worldwide[1]. Among the risk factors associated with CVD, obesity and its related comorbidities have gained significant attention in recent years. Abdominal obesity, in particular, has been identified as a pivotal contributor to CVD development and progression[2]. A comprehensive understanding of the association between abdominal fat distribution and CVD risk factors is essential for early diagnosis, intervention, and risk stratification.

Numerous studies have investigated the link between abdominal adiposity and CVD, often focusing on body mass index (BMI) or waist circumference (WC) as measures of obesity[3,4]. However, these conventional metrics may not fully capture the complexity of fat distribution within the abdominal cavity. In recent years, abdominal wall fat index (AFI) measured by ultrasonography has emerged as a precise and sensitive marker of abdominal fat distribution[5]. AFI is a measure of the amount of fat present in the abdominal wall, which can be assessed using ultrasound imaging[6]. AFI quantifies the thickness of subcutaneous and visceral fat layers, providing valuable insights into the localization of adipose tissue[7].

Carotid intima-media thickness (CIMT) has been established as a reliable surrogate marker for atherosclerosis and an independent predictor of CVD risk[8]. CIMT is a measure of the thickness of the innermost layer of the carotid artery, which is indicative of atherosclerosis and cardiovascular risk [9] Elevated CIMT is indicative of subclinical atherosclerosis and is closely associated with dyslipidemia, another well-established risk factor for CVD[10].

The relationship between AFI and CIMT can be explained by the fact that abdominal fat, particularly visceral fat, is metabolically active and can release various pro-inflammatory cytokines and adipokines[11]. These substances can cause systemic inflammation and oxidative stress, leading to endothelial dysfunction and the development of atherosclerosis[12,13].

Additionally, abdominal fat can contribute to insulin resistance and dyslipidemia, both of which are risk factors for cardiovascular disease[14,15]. The accumulation of abdominal fat can also lead to an increase in blood pressure, further contributing to the development of atherosclerosis[16]. On the other hand, Insulin resistance can lead to increased levels of triglycerides and LDL cholesterol, while decreasing levels of HDL cholesterol[12].

Dyslipidemia, characterized by abnormal lipid profile parameters such as elevated total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), and decreased high-density lipoprotein cholesterol (HDL-C), contributes significantly to atherogenesis[17].

Various Imaging techniques used to evaluate abdominal fat including CT, MRI, and sonography. Both MRI and CT measurements offer excellent reproducibility and the ability to assess fat deposit volumes using multislice approaches. CT is often regarded as the gold standard for assessing adipose tissue, but it comes with relatively high costs and exposes patients to ionizing radiation. On the other hand, MRI, while avoiding ionizing radiation, is known for its limited availability, elevated expense, and a tendency to overestimate fat deposits[13]. on the other hand research has proposed the use of ultrasound over CT and MRI due to its myriad benefits, such as being non-invasive, cost-effective, and reduced radiation exposure compared to other imaging modalities like computed tomography (CT) or magnetic resonance imaging (MRI)[18].

This research endeavors to contribute to this growing body of knowledge by exploring the intricate associations between AFI, CIMT, and lipid profile parameters.

Aim of the work: The aim of this study is to investigate and analyze the relationship between abdominal wall fat index (AFI), as measured by ultrasonography, and Carotid Intima Media Thickness (CIMT), with a particular focus on exploring the associations with lipid profile. By examining these variables, we seek to enhance our understanding of the potential correlations between abdominal fat distribution, vascular health, and lipid metabolism

Materials and Methods

Study design and setting

The present cross-sectional study was carried out in Sulaymaniyah teaching hospital, Kurdistan region, Iraq from December 2022 to August 2023.

Study sample and sampling method

The study employed a prospective cohort design involving 80 participants who met specific eligibility criteria. Ultrasonography was used to measure the abdominal fat index and carotid intima media thickness, along with assessing the lipid profile. These results were subsequently compared to the participants' body mass index (BMI). Inclusion criteria specified individuals aged 18 to 75 with a BMI between 18.5 and 40, no pregnancy or lactation, no history of uncontrolled endocrine or cardiovascular diseases, bleeding disorders, or recent use of weight loss medications or supplements within the past 3 months. Participants were also required to have not employed other weight reduction methods. Exclusion criteria encompassed individuals younger than 18 or older than 75, those undergoing weight loss surgery during the study, and individuals using corticosteroids or contraceptive medication.

Data collection and analysis

The study gathered the following data from participants: their age, gender, marital status, occupation, smoking and alcohol consumption habits, and past medical history. Additionally, the patients' weight and height were measured to calculate their BMI using the formula: Weight in kilograms divided by height in meters.

Furthermore, ultrasound examinations were performed to assess the (AFI) and (CTMT). With the patient in the supine position, the Abdominal Fat Index (AFI) was measured using an 8-MHz linear transducer probe positioned vertically at a 90-degree angle on the epigastrium. The measurement was taken, and the AFI was computed as the ratio of the maximum thickness of the preperitoneal fat at the anterior surface of the liver to the minimum thickness of the subcutaneous fat (**Figure 1** & **2**).

Carotid intima-media thickness (CIMT) is assessed using established protocols to ensure precision. It is imperative to avoid areas with atheromatous plaques during measurements. The assessment involves measuring between the two distinct lines formed by the blood-intima interface and the media-adventitia junction, representing the far and near walls, respectively. To ensure accurate measurements, the patient is positioned in a supine stance with the head turned away from the examination side. Sagittal imaging of the common carotid artery (CCA) is conducted, and a minimum of five measurements are taken on each side to calculate an average value known as "average CIMT." Measurements are specifically taken on the posterior wall of the common carotids, both on the right and left sides, approximately 1 cm away from the carotid bifurcation (**Figure 3**).

Subsequently, participants underwent blood tests to assess their lipid profile in the laboratory. Statistical analysis was conducted using the Statistical Package for Social Sciences (SPSS), version 24.0. This analysis encompassed both descriptive and inferential statistical tests. The measurements of abdominal subcutaneous and visceral thickness were also part of the study's assessments.

Ethical considerations

The study's protocol was approved by the Ethics Committee of Kurdistan board for medical spatiality and ministry of health in Kurdistan region (2023/11/28 -1972), Moreover, informed consent was obtained from all participants.

Result

The study sample included 80 patients, 63.75% were females, and the other 36.25% were males. The majority fall within the age group between 45-55year. At the same time, a smaller percentage of 27.5% were between 35-45years old (**Figure 4**). About 22.5%of the patients had smoking history, while the other 77.5% did not, and no patient gives history of ex-smoker, as shown in **table I**.

Figure 1: Drawing shows anatomic landmarks for sonographic estimation of maximum preperitoneal fat thickness and minimum subcutaneous fat thickness[13].

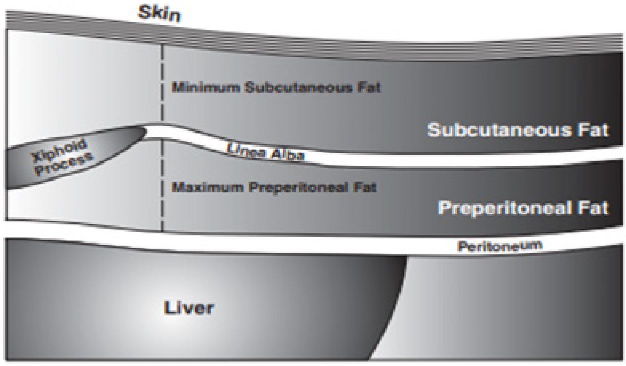

Figure 2: AFI measurement using ultrasound linear probe 8-MHz positioned at a 90-degree angle at epigastric region.

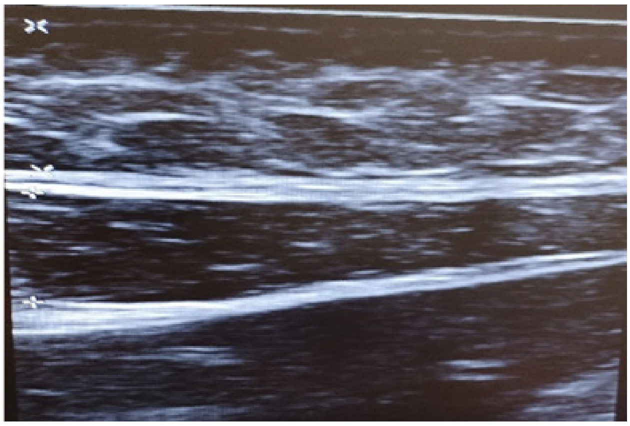

Figure 3: CIMT measurement, sagittal imaging of the Common carotid artery on both side used at 1 cm from the carotid bifurcation.

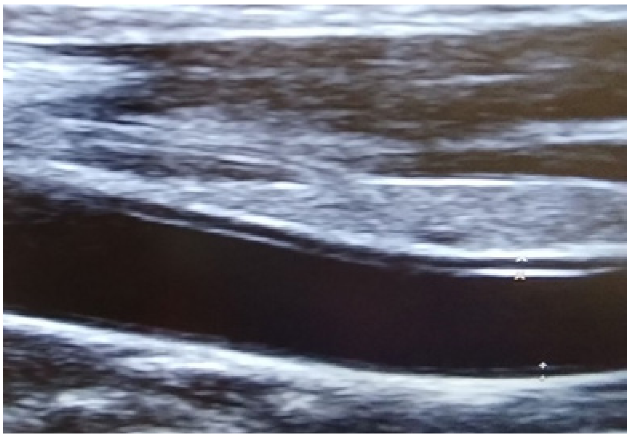

Figure 4: Patients' age group.

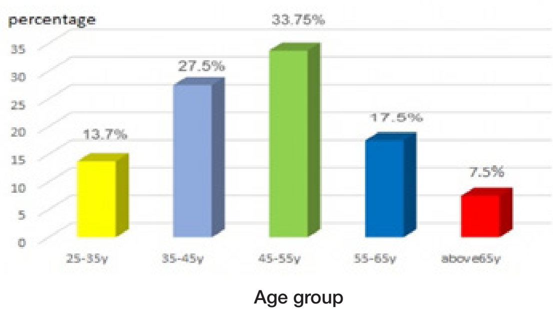

Table I: Socio-demographic characteristics of the participant.

Socio-demographic character		Frequency	Percent
Gender	F	51	63.75
	M	29	36.25
Age Group	(25-35) Years	11	13.75
	(35-45) Years	22	27.5
	(45-55) Years	27	33.75
	(55-65) Years	14	17.5
	Above 65 Years	6	7.5
Smoking	No	62	77.5
	Yes	18	22.5
	Ex-smoker	0	0
Alcoholism	No	80	100
	Yes	0	0
Education	No	20	25
	Yes	60	75
Total		80	100.0

Table II: Distribution of BMI Categories and Corresponding Abdominal Fat Index (AFI) Ranges in the Study Population.

BMI	obesity	frequency	percentage	AFI range
18.5 to 24.9	normal	11	13.75	1.193 to 2.18
25 to 29.9	overweight	31	38.75	0.68 to 4.2
≥30	obese	38	47.5	0.062 to 2.77

Table III: AFI correlation with BMI, CIMT and Lipid profile.

	correlation coefficient (95% CI)	P value	n
BMI	-0.282 (-0.472; -0.0662)	**0.011**	
carotid	0.411 (0.210; 0.578)	**<0.001**	
S Cholesterol	0.365 (0.158; 0.541)	**<0.001**	
TG	0.486 (0.298; 0.638)	**<0.001**	
LDL	-0.0434 (-0.261; 0.178)	**0.7**	80
HDL	-0.0321	0.78	

The distribution of participants across various BMI categories revealed distinct patterns in the study population (**Table II**). Participants within the normal BMI range (18.5 to 24.9) constituted 13.75% of the population, displaying an AFI range from 1.193 to 2.18. The overweight category (BMI 25 to 29.9) encompassed the largest segment, with 38.75% of participants and an AFI range of 0.68 to 4.2. Notably, the obese category (BMI ≥ 30) constituted 47.5% of the participants, revealing an AFI range spanning from 0.062 to 2.77. These findings emphasize the varied distribution of abdominal fat index across different BMI categories, contributing valuable insights for further interpretation and understanding of the study's results.

In examining the relationship between Abdominal Fat Index (AFI) and various health indicators, significant findings emerge. Firstly, a noteworthy negative correlation exists between Body Mass Index (BMI) and AFI ($r = -0.282$, $p = 0.011$), indicating that as BMI decreases, AFI tends to increase. The 95% confidence interval for this correlation spans from -0.472 to -0.0662.

Secondly, Carotid Intima Media Thickness (Carotid) demonstrates a substantial positive correlation with AFI ($r = 0.411$, $p < 0.001$). The correlation coefficient's 95% confidence interval lies between 0.210 and 0.578, underscoring the robustness of this association.

Moreover, Serum Cholesterol exhibits a significant positive correlation with AFI ($r = 0.365$, $p < 0.001$), as evidenced by a correlation coefficient ranging from 0.158 to 0.541 within the 95% confidence interval.

Triglycerides (TG) also display a meaningful positive correlation with AFI ($r = 0.486$, $p < 0.001$), with a 95% confidence interval spanning from 0.298 to 0.638.

On the other hand, no statistically significant correlations were observed between AFI and Low-Density Lipoprotein (LDL) Cholesterol ($r = -0.0434$, $p = 0.7$) or High-Density Lipoprotein (HDL) Cholesterol ($r = -0.0321$, $p = 0.78$).

These findings collectively elucidate the intricate interplay between AFI and diverse health parameters, shedding light on potential implications for clinical and research contexts (**Table III**).

Discussion

The present study delved into the intricate correlation between abdominal fat index (AFI), measured through ultrasonography, and a spectrum of anthropometric, vascular, and lipid profile parameters. This exploration has yielded a wealth of information, uncovering significant correlations that contribute to our understanding of the nuanced relationship between abdominal fat distribution and cardiovascular health.

One of the key findings of the study is the negative correlation identified between Body Mass Index (BMI) and AFI. The statistical significance, as indicated by a p-value below 0.05, underscores that the identified negative correlation between BMI and AFI is unlikely to be a result of random chance. However, it's crucial to note that the strength of this correlation, represented by a moderate correlation coefficient of -0.282, suggests a measurable but not a very strong relationship. While statistically significant, the moderate effect size implies that factors beyond BMI may contribute to the variability observed in AFI. Consequently, interpreting the results necessitates considering the clinical context and the practical significance of this correlation.

Body Mass Index (BMI, a straightforward ratio of weight to height) is a widely utilized and valuable metric, yet its accuracy is influenced by diverse factors such as lifestyle, physical activity, and muscle mass. Moreover, BMI has limitations in distinguishing between muscle and fat mass and in discerning fat distribution throughout the body. In contrast, Abdominal Fat Index (AFI), which specifically targets abdominal fat, provides a more precise evaluation of fat distribution, holding significance for health outcomes.

The intriguing correlation between AFI and BMI challenges conventional expectations regarding the relationship between overall body mass and abdominal fat distribution. This discovery implies that individuals with higher BMI values tend to exhibit lower AFI, indicating a potential dissociation between general and abdominal obesity. This nuanced perspective facilitates a more comprehensive understanding of changes in body composition, offering valuable insights into the intricate interplay of factors influencing health. Therefore, the study underscores the importance of moving beyond the traditional reliance on BMI for a more nuanced and clinically relevant assessment of body composition.

Research supporting the negative correlation between BMI and AFI suggests that depending solely on BMI may oversimplify the complex interplay between body composition and cardiovascular health. The concept of a negative correlation between BMI and abdominal fat distribution has been explored in various studies, with a growing recognition of BMI's limitations in capturing intricate relationships between different body fat compartments and their distinct implications for health[19]. These findings emphasize the significance of employing more sophisticated measures, such as abdominal fat indices derived from imaging techniques like ultrasonography, to gain a more accurate understanding of adipose tissue distribution and its impact on cardiovascular risk. In contrast to the study conducted by Ahmad et al.[20] our research revealed a negative correlation between AFI and BMI. While their findings suggested that higher BMI was associated with increased AFI, our results indicate the opposite trend. Several factors could contribute to this discrepancy: Population Differences, Physiological Factors, comorbidities, and health condition of our patients, Future research should explore these factors comprehensively to unravel the intricate relationship between AFI and BMI.

In conclusion, the negative correlation between AFI and BMI challenges simplistic assumptions about the association between overall body mass and abdominal fat distribution. This underscores the need for a more nuanced approach to evaluating body composition in the context of cardiovascular risk, recognizing the limitations of BMI and highlighting the importance of advanced imaging techniques in unraveling the complexities of body fat distribution.

Moreover, the positive correlations observed between AFI and Carotid Intima Media thickness provide valuable insights into the potential impact of abdominal fat on cardiovascular health. CIMT is a well-established marker of subclinical atherosclerosis and is closely linked to the development of cardiovascular diseases. Positive correlations were found between abdominal wall fat index (AFI) measured by ultrasound and Carotid Intima Media Thickness (CIMT) in various studies. A study on overweight and obese patients revealed a significant positive correlation between AFI and CIMT, indicating a relationship between regional fat accumulation and early atherosclerosis[20]. Additionally, another study highlighted that AFI was positively associated with pathological CIMT, independent of other confounders, emphasizing the predictive capacity of AFI for carotid artery atherosclerosis[21]. Furthermore, research on children showed significant relationships between subcutaneous and visceral fat thickness, fatty liver grade, and lipid profiles, although the correlation with CIMT was not as pronounced[22]. These findings collectively suggest that AFI measured by ultrasound can serve as a valuable marker for assessing the risk of atherosclerosis and related cardiovascular complications. Studies have consistently shown that individuals with higher abdominal wall fat index tend to exhibit greater carotid intima-media thickness and our findings align with prior research and has consistently linked abdominal adiposity to an elevated risk of atherosclerosis and dyslipidemia[20], reinforcing the significance of understanding abdominal fat distribution as a key factor in assessing cardiovascular risk.

The study reveals strong positive correlation of AFI with serum cholesterol and triglyceride while intriguing lack of a significant correlation between AFI and LDL or HDL cholesterol prompts further exploration into the nuanced relationship between abdominal fat distribution and specific lipid metabolism aspects. This suggests that AFI might be more closely tied to certain facets of lipid metabolism and vascular health than others, indicating potential variations in how abdominal fat influences lipid profiles. Our findings are supported by previous articles which revealed positive correlations between abdominal wall fat index (AFI) and serum cholesterol and triglyceride levels. Studies have shown that AFI is positively correlated with lipid profile parameters[20,23]. Additionally, the abdominal wall fat index (AFI) has been associated with cardiometabolic abnormalities, including a positive correlation with diastolic blood pressure and pulse pressure[24]. Furthermore, the Visceral Adiposity Index (VAI), which is related to AFI, has shown significant correlations with visceral fat, triglyceride levels, and other metabolic parameters[25].

In summary, the study underscores the critical role of ultrasonography in assessing abdominal fat distribution concerning cardiovascular risk factors. The findings accentuate the need for additional research to unravel the underlying mechanisms driving these correlations. Moreover, expanding the scope of investigations to larger and more diverse populations will contribute to a comprehensive understanding of the clinical implications of these findings. As we continue to unravel the complexities of the interplay between abdominal fat distribution and cardiovascular health, the insights from this study pave the way for more targeted and effective interventions to mitigate cardiovascular risks associated with abdominal adiposity.

Conclusion

AFI measurement using ultrasound presents a valuable alternative to both advanced imaging methods and the collection of anthropometric data. It offers a noninvasive, safe, accurate, reproducible, and cost-effective approach, with the added benefit of avoiding ionizing radiation exposure for patients. Sonographic findings exhibit strong correlations with CIMT and lipid profile, so it may facilitate the direct assessment of cardiovascular and metabolic risk factors. However, it is important to acknowledge certain limitations associated with the use of sonography for body composition assessment. There is a clear need for the development of objective and accurate indices tailored to specific patient groups. Adequate training of examiners is imperative to ensure reliable and reproducible measurements. Addressing these challenges could pave the way for the routine clinical use of sonography in assessing regional adiposity. Further studies should consider a larger and more diverse sample to generalize these findings to a broader population

Conflict of Interests

The author has no conflicts with any step of the article preparation.

Ethics approval and consent to participate

The study's protocol was approved by the Ethics Committee of Kurdistan board for medical spatiality and ministry of health in Kurdistan region

Informed Consent

Informed consent was obtained from all participants.

Availability of data and material

Data are available from the corresponding author upon request

Authors' contributions

The authors have contributed equally in this research study.

Funding

Non

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