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Integrated Study Master Thesis

The Assessment of Adipose Tissue Distribution Among Patients with Ischemic Heart Disease from Different Social and Demographic Groups

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1. List of abbreviations:

ACS = Acute Coronary Syndrome

AUC = Area Under the Curve

BMI = Body Mass Index

CAD = Coronary Artery Disease

CCTA = Coronary Computed Tomography Angiography

CI = Confidence Interval

CRP = C-reactive Protein

CT = Computed Tomography

CVD = Cardiovascular Disease

DXA = Dual-energy X-ray Absorptiometry

EAT = Epicardial Adipose Tissue

EATD = Epicardial Adipose Tissue Density

EATV = Epicardial Adipose Tissue Volume

FM = Fat Mass

GWAS = Genome-Wide Association Study

HDL = High-Density Lipoprotein

HR = Heart Rate

HU = Hounsfield Units

IHD = Ischemic Heart Disease

IQR = Interquartile Range

MDD = Major Depressive Disorder

MESA = Multi-Ethnic Study of Atherosclerosis

MRI = Magnetic Resonance Imaging

NHANES = National Health and Nutrition Examination Survey

OR = Odds Ratio

PAT = Pericardial Adipose Tissue

PCATMA = Pericoronary Adipose Tissue Mean Attenuation

PVAT = Perivascular Adipose Tissue

ROC = Receiver Operating Characteristic

SAT = Subcutaneous Adipose Tissue

SD = Standard Deviation

SES = Socioeconomic Status

TNF = Tumor Necrosis Factor

VAT = Visceral Adipose Tissue

VFA = Visceral Fat Area

VSR = Visceral-to-Subcutaneous Fat Ratio

WAT = White Adipose Tissue

WC = Waist Circumference

WHR = Waist-to-hip ratio

p = p-value (statistical significance)

r = Correlation Coefficient

ß = Beta Coefficient (standardized regression coefficient)

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3. Summary and key words

Key words:

adipose tissue, distribution, visceral, subcutaneous, cardiac, ischemic heart disease.

Summary:

Brief substantiation of the research

There is increasing evidence that the distribution of adipose tissue such as subcutaneous, visceral or cardiac fat depots and not only total body fat play a critical role in cardiovascular risk. Despite the differences in the risk of ischemic heart disease between the different social and demographic groups, a possible association between sociodemographic factors and the distribution of fat depots remains underexplored in context of ischemic heart disease.

Aim and objectives of the research

The **aim of this study** was to review scientific literature about the association of the distribution of adipose tissue with various social and demographic factors among patients with ischemic heart disease

The objectives included the analysis of:

1. Subcutaneous adipose tissue among social and demographic groups of patients with ischemic heart disease;

2. Abdominal visceral adipose tissue among social and demographic groups of patients with ischemic heart disease;

3. Cardiac adipose tissue (epicardial, pericardial, paracardial, perivascular) among social and demographic groups of patients with ischemic heart disease.

Research methods

A narrative literature review was conducted via structured searches with keywords and MeSH-terms in PubMed and Google Scholar. The selection criteria included studies focusing on fat depot distribution in relation to sex, ethnicity, or socioeconomic indicators, particularly in cardiovascular contexts.

Results

Studies have shown that men often exhibit greater visceral adiposity, women often have more subcutaneous fat until menopause, showing a possible hormonal influence. Asian individuals often demonstrate higher visceral and epicardial fat at lower body mass index values, African Americans often have lower visceral adiposity but similar metabolic risk. Lower occupational status is often associated with larger depots of visceral fat, while lower education, older age and belonging to a non-White ethnic group often predicts a higher ratio of visceral to subcutaneous adipose tissue. Cardiac fat increased with age and was higher in men. Epicardial fat was more common in South and East Asians and Whites, and associated with alcohol use, hypertension, and diabetes. Epicardial adipose tissue emerged as a clinically valuable and potentially modifiable marker of early cardiovascular risk.

Conclusions

Demographic and social factors are associated with differences in the accumulation of adipose tissue. These findings suggest the need for inclusion of social factors and imaging-based fat depot measurement into cardiovascular screening in vulnerable populations to improve early detection of high-risk individuals.

4. Introduction

Cardiovascular diseases (CVDs) are the leading cause of mortality worldwide, accounting for a third of all global deaths and contributing to reduced quality of life (46; 34). Despite advances in prevention and treatment, their prevalence continues to rise due to risk factors such as hypertension, diabetes, dyslipidemia, and obesity, all of which contribute to disease progression (39).

Controlling modifiable risk factors, particularly obesity, is crucial in reducing morbidity and mortality related to CVD (48). In western high-income countries, there is an inverse association between socioeconomic status (SES) and CVD as well as cardiovascular risk factors (29).

Obesity is defined by excessive fat accumulation that poses health risks, with a body mass index (BMI) over 30 kg/m² classified as obese (48). Also, the global rise in obesity leads to major medical and economic costs (5). Morphologically, adipose tissue can be divided into white, brown and beige. White adipose tissue (WAT) accumulates in two primary depots and can be accordingly classified into visceral or ectopic (within the visceral cavity, VAT) and subcutaneous (below the skin, SAT) (12).

Ectopic fat, especially visceral and epicardial fat, is more predictive of cardiovascular risk than BMI alone (12; 39).

Growing evidence suggests that the risk conferred by adipose tissue depends not only on quantity but also on distribution, which in turn may be shaped by sociodemographic factors such as sex, age, ethnicity, and socioeconomic position. While some general associations have been observed, for example men tending to store more visceral fat and women more subcutaneous fat until menopause, or ethnic differences in fat storage patterns, the distribution of clinically relevant fat depots across diverse population groups in IHD has not yet been systematically synthesized (17; 50).

This is despite ischemic heart disease does not affect all population groups equally. Its prevalence and severity vary by socioeconomic status, sex, and ethnicity and currently there is a lack of research regarding a possible association between sociodemographic factors and the distribution of fat depots in context of ischemic heart disease (5, 29).

The aim of this thesis is to examine how subcutaneous, visceral, and cardiac adipose tissue (including epicardial, pericardial, paracardial, and perivascular fat) are distributed across social and demographic groups in patients with ischemic heart disease. Findings of the research could lead to improvement in cardiovascular risk assessment and prevention strategies by linking social factors to physiological ones.

The objectives of this thesis are to review the literature on the accumulation of:

1. Subcutaneous adipose tissue among social and demographic groups of patients with ischemic heart disease;

2. Abdominal visceral adipose tissue among social and demographic groups of patients with ischemic heart disease;

3. Cardiac adipose tissue (epicardial, pericardial, paracardial, perivascular) among social and demographic groups of patients with ischemic heart disease.

5. Methodology

This thesis conducted a narrative literature review to investigate differences and similarities in the accumulation of subcutaneous, visceral, and cardiac adipose tissue across demographic and social groups in patients with ischemic heart disease.

The literature search was conducted between March 2024 and April 2025. PubMed served as the primary database, complemented by supplementary searches via Google Scholar.
Keywords included “adipose tissue”, “distribution”, ”visceral”, “subcutaneous”, “cardiac”, “ischemic heart disease”.

MeSH terms were also applied to refine the search results. Reference lists from selected studies were screened to identify additional relevant sources.

Only scientific publications were included, while non-academic sources, such as news articles or editorials, were being excluded. The included publications were restricted to English-language texts to ensure clarity and accessibility for a broader readership.
Studies published before 2014 were generally excluded to maintain topical relevance, unless older sources provided foundational insights not available in newer literature.
There were no restrictions on study design. This open approach was chosen to ensure a comprehensive capture of relevant findings.

For screening of possibly relevant studies, titles and abstracts were reviewed first for relevance. Afterwards full texts of eligible studies were then analysed.
After applying the inclusion and exclusion criteria, 34 studies were selected for in-depth analysis. Data were extracted and organized thematically according to fat depot (subcutaneous, visceral, cardiac) and sociodemographic dimensions (sex, ethnicity, age, socioeconomic status). This structured approach enabled comparative analysis across studies despite heterogeneity in populations and methods.

MeSH Terms Used in Literature Search

Purpose of Query	Corresponding MeSH Terms
Differences and similarities in subcutaneous adipose tissue across social and demographic groups in patients with ischemic heart disease	"Subcutaneous Fat"[MeSH] OR "Adipose Tissue, Subcutaneous"[MeSH] AND "Coronary Artery Disease"[MeSH] OR "Myocardial Ischemia"[MeSH] OR "Ischemic Heart Disease"[MeSH] AND "Socioeconomic Factors"[MeSH] OR "Social Class"[MeSH] OR "Income"[MeSH] OR "Educational Status"[MeSH] OR "Health Disparities"[MeSH] OR "Ethnicity"[MeSH] OR "Sex Factors"[MeSH] OR "Age Factors"[MeSH]
Differences and similarities in visceral adipose tissue across social and demographic groups in patients with ischemic heart disease	"Visceral Fat"[MeSH] OR "Abdominal Fat"[MeSH] OR "Intra-Abdominal Fat"[MeSH] OR "Adipose Tissue, Intra-Abdominal"[MeSH] AND "Coronary Artery Disease"[MeSH] OR "Myocardial Ischemia"[MeSH] OR "Ischemic Heart Disease"[MeSH] AND "Socioeconomic Factors"[MeSH] OR "Social Class"[MeSH] OR "Income"[MeSH] OR "Educational Status"[MeSH] OR "Health Disparities"[MeSH] OR "Ethnicity"[MeSH] OR "Sex Factors"[MeSH] OR "Age Factors"[MeSH]
Differences and similarities in cardiac adipose tissue (epicardial, pericardial, paracardial, perivascular) across social and demographic groups in patients with ischemic heart disease	"Epicardial Fat"[MeSH] OR "Pericardial Fat"[MeSH] OR "Perivascular Fat"[MeSH] OR "Adipose Tissue, Pericardial"[MeSH] OR "Adipose Tissue, Epicardial"[MeSH] OR "Paracardial Fat"[MeSH] AND "Coronary Artery Disease"[MeSH] OR "Myocardial Ischemia"[MeSH] OR "Ischemic Heart Disease"[MeSH] AND "Socioeconomic Factors"[MeSH] OR "Social Class"[MeSH] OR "Income"[MeSH] OR "Educational Status"[MeSH] OR "Health Disparities"[MeSH] OR "Ethnicity"[MeSH] OR "Sex Factors"[MeSH] OR "Age Factors"[MeSH]

Table 1: Search-Queries and MeSH-Terms

6. Overview: Adipose Tissue

Adipose tissue is defined as a mosaic organ that contains mature adipocytes, immune cells, neurons, and stromal vascular cells. It is now recognized as a principal site for hormone production and a critical regulator of body temperature. Adipose tissue also secretes adipokines, which are adipose-derived proteins or cytokines that mediate endocrine and paracrine effects (14).

The fat depots this thesis is concerned with are subcutaneous, visceral and cardial (epicardial, pericardial, paracardial, perivascular) fat depots, which all have different characteristics and cardiovascular implications, which are reflected in the state of research.

To explain the importance of adipose tissue, from a historical perspective it should be mentioned that adipose tissue was understudied due to the false assumption that it is a mere energy storage depot. The view on adipose tissue was changed by the scientific revelation of the various properties of adipocytes and their role in the functioning of the human body, which according to Richard, has led to a “scientific renaissance” in the research of adipose tissue. These include for example the release of endocrine hormones but also of effectors like lipids, inflammatory cytokines and peptide hormones. It therefore functions not only as a fat reservoir but also as an endocrine organ impacting local and systemic metabolic responses due to the paracrine and endocrine capacities of its released substances (40).

Adipose tissue itself includes various subtypes of fat cells with specialized roles, which are organized into depots in distinct anatomical regions in the body. Even within a single depot, fat cells can differ in their function with studies suggesting a strong link between how these fat cells work and overall metabolic health (52).

Additionally, in recent decades, adipose tissue has been recognized as a key regulator of systemic insulin sensitivity and overall substrate metabolism. The distribution of adipose tissue contributes significantly to determining the risk for metabolic and cardiovascular diseases. Visceral adipose tissue (VAT) and ectopic fat depots are closely linked to an increased risk of cardiometabolic disorders, whereas subcutaneous adipose tissue (SAT) appears to have a lesser, potentially neutral, impact. Advancing our understanding of the mechanisms driving fat accumulation in visceral and ectopic sites is essential for improving therapeutic strategies against cardiometabolic disease (52).

As mentioned in the introduction, obesity is defined by excessive fat accumulation that poses health risks, with a body mass index (BMI) over 30 kg/m^2 classified as obese (48).

This excess fat storage in adipose tissue happens in situations, where there is an excess in energy. Less visible, but equally important is that obesity is paired with dysregulation and loss of adipocyte function in individually different degrees, according to Ziegler and Scheele (52). Regarding the measurement of obesity in relation to cardiometabolic disease, studies show that methods such as hip to waist ratio or waist circumference are more valuable in prognosticating cardiometabolic disease than the traditional body max index (BMI) (52).

As Yaghootkar et al. point out, the BMI has limitations in distinguishing fat and lean mass and is therefore not suitable for accurately estimating body fatness. This may explain, why based on BMI 50% of overweight and 30% of obese individuals do not have any sign of metabolic or cardiovascular complications.

While the benefit of hip to waist ratio or waist circumference in estimating cardiometabolic disease risk in comparison to BMI has been mentioned, these anthropmetric measurements are not able to differentiate between fat depots such as visceral and subcutaneous. In the following figure an example of this from the publication 'Ethnic differences in adiposity and diabetes risk – insights from genetic studies' published in *Journal of Internal Medicine*, by Yaghootkar et al. can be seen. It depicts transverse slices of an abdominal MRI of two people with same BMI or waist circumference, age and gender that have diverging levels of specific fat tissues (visceral, subcutaneous and liver fat) and accordingly a distinct cardiometabolic disease risk (50).

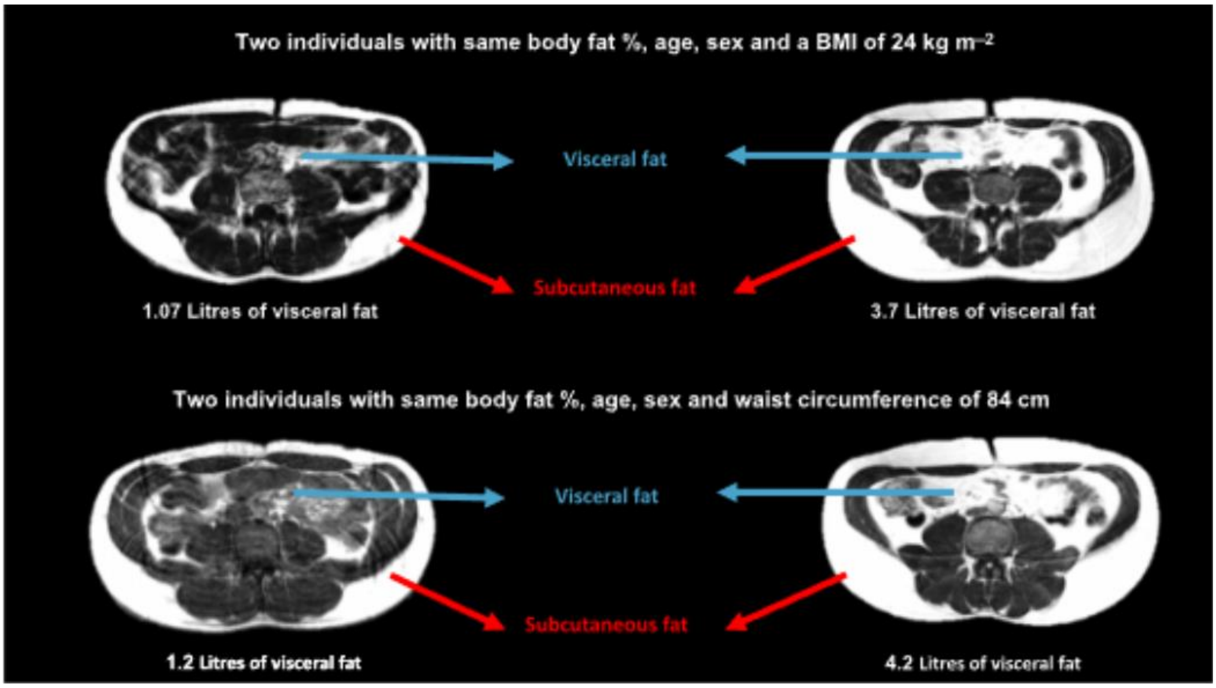

Figure 1: Demonstration of diverging levels of fat tissue via transverse slices of an abdominal MRI of two people with same BMI or WC, age and gender by Yaghootkar et al. 2020

As Ziegler and Scheele explain in the context of abdominal obesity, notable changes occur in how different fat depots function. Looking at specific fat depots, SAT in particularly the gluteofemoral region, declines in its adipogenic capacity (the ability to produce new fat cells) storage. VAT on the other hand is more metabolically active and compensates as lipid storage site instead of SAT. This redistribution of fat not only alters storage dynamics but also leads to low-grade inflammation in VAT. Furthermore, in cardiometabolic disease a loss of thermogenic function in fat regions such as the supraclavicular and deep neck areas is observed, which leads Ziegler and Scheele to the conclusion that in cardiometabolic disease, adipose tissue across depots is functionally compromised (52).

With the focus of this thesis being on the accumulation and distribution of adipose tissue, it should be understood that adipose tissue is not a single tissue, but can be divided into white, brown and beige adipose tissue. For this thesis, white adipose tissue is the most relevant and accumulates in two primary depots. Those depots can be classified according to their location into visceral or ectopic (within the visceral cavity, VAT) and subcutaneous (below the skin, SAT) (12).

Although total fat mass contributes significantly to cardiometabolic risk, the anatomical position is even more decisive. This is due to the reason that the different fat depots have unique biological properties and differ in their function and health implications. (39).

Especially relevant is the finding that ectopic fat is associated with higher cardiovascular risk (39) with studies indicating that VAT and EAT are more reliable predictors of metabolic and cardiovascular risk than BMI alone (12).

Ectopic fat accumulation is not merely a marker of cardiometabolic disease but also actively contributes to its pathophysiology. Through the release of adipocytokines, as well as lipotoxic and glucotoxic agents, ectopic fat interacts with insulin-sensitive organs, promoting metabolic, cardiac, and vascular dysfunction. This pathological crosstalk further exacerbates insulin resistance and increases the risk of cardiovascular complications (18)

Subcutaneous adipose tissue (SAT), found beneath the skin, represents 80% of total adipose tissue in healthy individuals with its main function being a storage site for excess energy (12: 2). Meanwhile, Visceral adipose tissue (VAT), which surrounds internal organs, plays a significant role in systemic inflammation and metabolic impairment due to releasing free fatty acids into the portal circulation. VAT accumulation is associated with metabolic syndrome since it contributes to development of its features such as insulin resistance, dyslipidemia, and atherosclerosis (12). Furthermore, VAT is being associated with a much higher CVD risk profile in comparison to SAT. Therefore, very low VAT in obese patient has been termed metabolically healthy obesity (39).

The different cardiac adipose tissues are not as easy to define due to the anatomical proximity and gradual transition from depot to depot. A subsuming term is thoracic visceral adipose tissue, which includes three main components: epicardial adipose tissue (EAT), located between the heart and the visceral pericardium; pericardial adipose tissue, situated outside the pericardium; and non-pericardial thoracic fat, found elsewhere in the thoracic cavity. Additionally, perivascular adipose tissue (PVAT) is seen as a specialized subset, which surrounds coronary arteries and differs functionally from more distant EAT. Importantly, PVAT and non-PVAT EAT are not anatomically separated. PVAT has been defined as the fat layer within a distance equal to the artery’s luminal diameter. As an example, with a large vessel like the aorta, this zone extends up to 2 cm from the vessel's outer wall (23).

Due to the anatomical complexity, the following cross-sections of the heart by computed tomography (Figure 2) and an animated less complex figure (Figure 3) assist in the depiction of the anatomical location of the different cardiac depots with explanations provided below:

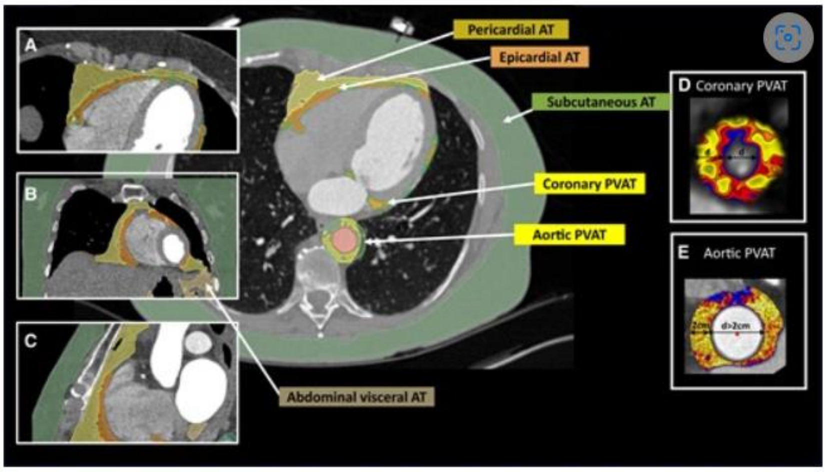

Figure 1 Imaging of human adipose tissue depots by computed tomography. Axial (*A*), coronal (*B*), and sagittal (*C*) views of the chest showing subcutaneous, visceral abdominal, thoracic (including the pericardial and epicardial) adipose tissue. Reconstruction of perivascular adipose tissue (PVAT) around an epicardial coronary artery (*D*) and thoracic aorta (*E*). PVAT is defined as the adipose tissue lying within a radial distance from the outer vessel wall equal to the vessel diameter (or at a maximum distance of 2 cm in the case of large vessels with diameter >2 cm, like the aorta).

Figure 2: cross-sections of the heart by computed tomography Antoniades et al. 2023

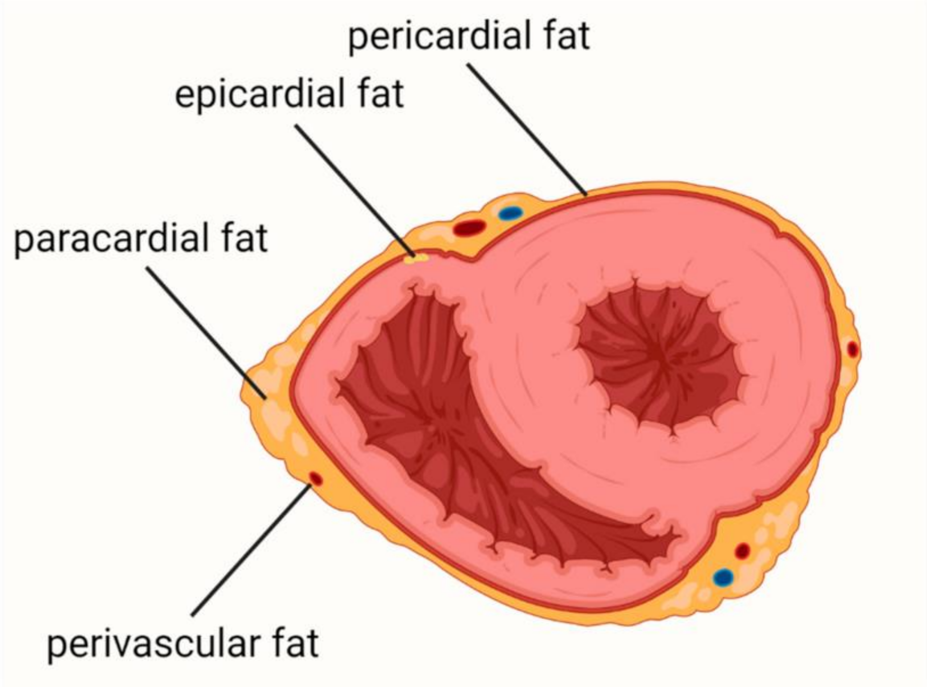

Figure 3: Cross-section of the heart with labeling of the cardiac fat depots by Konwerski et al. 2022.

Regarding the function of those different cardiac adipose tissue depots, epicardial adipose tissue (EAT), located around the heart, is associated with coronary artery disease (6) and according to Richard et al. one of the main culprits in the development of cardiovascular disorders due to its pro-inflammatory potential. As mentioned, it is positioned between the visceral pericardium and the myocardium, while pericardial adipose tissue (PAT) surrounds the pericardium (6; 40). Pericardial and epicardial fat are associated with coronary artery disease and metabolic risk through local paracrine effects. While its influence is generally weaker than VAT, its anatomical proximity to cardiac structures may contribute to localized cardiovascular pathology (42).

Iacobellis adds that the reason why EAT is playing a role in development and severity of CAD, is its capacity to lead to inflammation, endothelial damage, oxidative stress and the build up of glucose and lipids in the proximal coronary arteries (25). According to Powell-Wiley it is assumed that is corresponds with increased BMI, traditional cardiovascular risk factors and more atherogenic lipoprotein particles (39). Due to its association with HT, CAD and MI it is thought that in the assessment of cardiovascular risk in adults, the measurement of EAT volume is the most helpful for risk stratification (7). Therefore, Iacobellis argues that in the future direct efforts toward early recognition and modification of epicardial fat in asymptomatic, but viscerally obese persons with high CVD risk are needed (24).

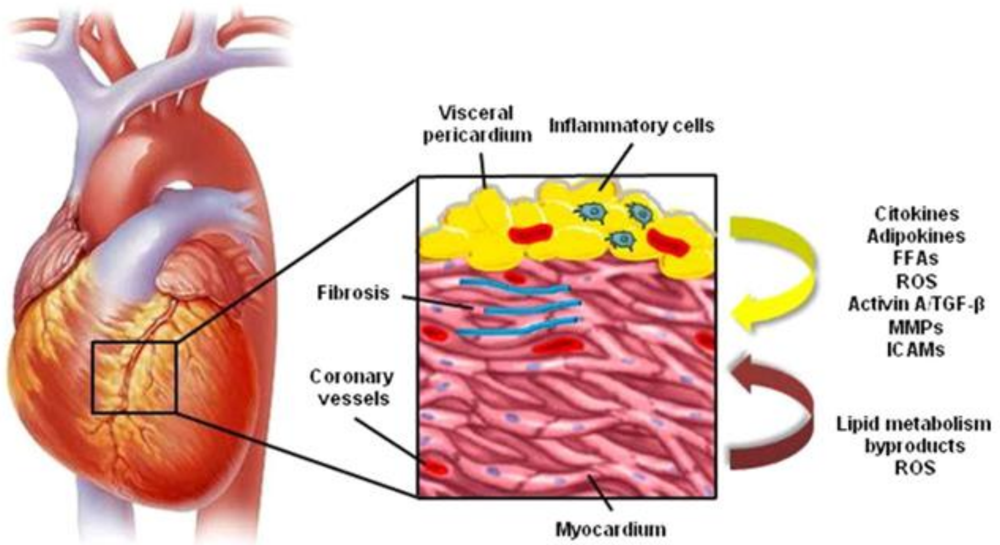

Figure 4:Illustration of potential signaling pathways, which are assumed to mediate the cross talk between EAT, myocardium and coronary vessels by Guglielmi/ Sbraccia from 2017

The mentioned potential signaling pathways, which are assumed to mediate the cross talk between EAT, myocardium and coronary vessels are illustrated in Figure 4 from a publication by Guglielmi and Sbraccia from 2017. Paracardial fat is part of the thoracic visceral fat and it is located within the chest cavity, but outside the pericardium. In contrast to pericardial fat, it is not directly in contact with the heart, but it might influence cardiac health through systemic inflammatory mediators (23).

In the following picture, the major sites of ectopic fat distribution can be observed for better visual understanding.

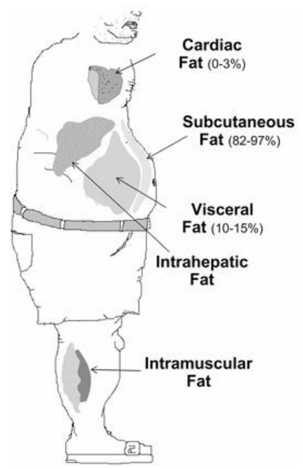

Figure 1 Major sites of ectopic fat distribution.

Figure 5: Illustration of major sites of ectopic fat distribution by Gastaldelli/ Basta 2010

Furthermore, ectopic fat accumulation in organs such as the liver and skeletal muscle is strongly linked to the development of insulin resistance, independent of visceral adipose tissue (VAT) levels (37).

In lean individuals with insulin resistance, skeletal muscle shows impaired carbohydrate utilization, resulting in a metabolic shift that promotes increased hepatic fat accumulation and de novo lipogenesis, even in the absence of changes in VAT. The exact mechanisms remain under investigation, but intracellular lipid accumulation appears to disrupt insulin signaling, particularly glucose transport.

Beyond VAT and subcutaneous adipose tissue (SAT), increased fat depots in the neck and upper body subcutaneous regions have also been independently associated with adverse cardiometabolic profiles, as shown in the Framingham Heart Study. These effects are likely due to their role as a major source of circulating free fatty acids (42).

According to Clark et al. from 2014 there is a need for further research of the role of visceral and ectopic fat depots, especially regarding biochemical activity, to better understand the pathophysiology of HF based on the observation of an association between obesity and improved survival in HF patients (13).

7. Literature review

7.1. Sex- and Ethnic differences and similarities in the accumulation of subcutaneous and visceral adipose tissue between the social and demographic groups of patients with IHD

Since many studies have looked at subcutaneous and visceral adipose tissue simultaneously, it is difficult to categorise some publications into research about SAT or VAT, therefore in this part sex and ethnic differences in adipose tissue accumulation are presented without separation between those two depots, while following with studies more specific to the before mentioned depots.

The study “The Sex and Race/Ethnicity-Specific Relationships of Abdominal Fat Distribution and Anthropometric Indices in US Adults” by Xu et al. from 2022 investigated the associations between anthropometric indicators (body mass index (BMI) and waist circumference (WC) and direct measures of abdominal fat distribution, namely visceral fat area (VFA) and the visceral-to-subcutaneous fat ratio (VSR), in a nationally representative sample of U.S. adults aged 20–59 years. The analysis utilized data from the 2011–2018 National Health and Nutrition Examination Survey (NHANES) and was stratified by sex and race/ethnicity. Age, education and income-to-poverty ratio were included into the regression models and therefore controlled for, but in the results no specific findings were mentioned. Regarding a possible effect of sociodemographic variables on VFA, VSR, BMI or WC no results were reported since they were only used for adjustment of the models but were not the focus of any subgroup comparisons and therefore their individual association with fat distribution was not investigated.

In terms of adipose tissue distribution, the study showed that BMI and other measures of obesity such as waist circumference (WC) are linearly associated with visceral fat area (VFA), patterns of fat distribution such as visceral to subcutaneous adipose area ratio (VSR) differ based on sex and ethnicity (49). For instance, the study found that for each unit increase in BMI, the VFA increased on average by $5.86cm^2$. Furthermore, every additional centimeter in WC was associated with a $2.64cm^2$ increase in VFA. This was evidenced by a concave BMI–VSR curve in males and a convex one in females, reflecting distinct fat distribution patterns across genders (49). The VSR in males decreased with increasing BMI up until 39.08 kg/m^2 and increased after this point. Meanwhile, in females the VSR increased with BMI up until 38.75 kg/m^2 and started to decline afterwards. In case of WC there were similar inflection points found at 144.5cm for men and 143.5 cm for women.

Additionally, racial differences were evident: White individuals exhibited a higher VFA at equivalent BMI or WC levels than Black, Hispanic, and Asian groups. For instance, in Whites the slope of BMI predicting VFA was 6.4, so how much the VFA is expected to increase for each 1-unit increase in BMI, (assuming all other variables in the model are held constant). In contrast, it was 5.63 in Hispanics, 6.04 in Asians and 3.79 in Blacks. Consequently, in Whites the WC was also more prognostic of VFA with β= 2.85 in comparison to Blacks with β = 1.75. Black individuals also had the lowest visceral fat overall. Regarding the visceral to subcutaneous adipose area ratio, racial/ethnic differences were found as well with black men and women having lower values than their counterparts from other groups (White, Hispanic and Asian) (49). Moreover, Blacks had the strongest negative association between BMI and VSR with $\beta1$ = -0.0899 (indicating greater subcutaneous fat relative to visceral fat), while in women the smallest increase in VSR per unit of BMI was in the Black subgroup with $\beta1$ = 0.0055 in comparison to Hispanics $\beta1$ = 0.0200 and Asians with $\beta1$ = 0.0201 (49).

In 2020, a study by Yaghootkar et al., published in Journal of Internal Medicine, examined whether ethnic variations in fat distribution may also influence cardiovascular risk. Methodically, they used a genetic epidemiological approach based on genome-wide association studies (GWAS). With Mendelian randomization and adiposity traits from UK Biobank data, which were imaging-derived, they investigated whether there are differences in fat distribution between ethnic groups and how this might affect metabolic outcomes without mentioning specific measurements due to the study design. Their research showed that in previous imaging studies South Asians exhibited not the highest amount of adipose tissue, but also a unfavourable central distribution pattern meaning they had larger visceral fat depots than their white European counterparts at the same WC, increasing their susceptibility to cardiovascular disease (CVD). African Americans, despite having less VAT and more muscle mass, faced a higher metabolic disease risk than Europeans, suggesting factors beyond fat distribution contribute to their health outcomes (50).

In 2022, a US-American study by Staiano and Katzmarzyk conducted a study to examine sex and race differences in adiposity development. The study design was a prospective cohort over a 2-year period in adolescents. Included into the study were 309 participants aged 10–16 years at baseline. Their characteristics were: 38% Black, 52% female, 15% were classified as overweight, and 34% as having obesity. For the measurement of the body composition, they used dual-energy X-ray absorptiometry (DXA) for total fat mass (FM). Abdominal subcutaneous adipose tissue (SAT) and visceral adipose tissue (VAT) were measured with Magnetic resonance imaging (MRI). In total, two measurements were conducted, one at baseline with (n=309) and a reassessment after two years (n = 236). To check for sex and race differences, general linear models were used. These were adjusted for age, sexual maturation, extended BMI percentile, and change in fat mass.

At baseline, looking at racial differences, FM was with 18.5 kg (95% CI: 17.9, 19.2) in White adolescents higher than in Black adolescents with 17.4 kg (95% CI: 16.6, 18.2), (P = 0.03). In terms of sex differences, Girls had higher FM (19.5 kg, 95% CI: 18.8, 20.3) than boys (16.5 kg, 95% CI: 15.8, 17.2, P < 0.0001). The SAT volume at baseline was with 4.4 L (95% CI: 4.2, 4.6) in girls also higher than in boys with 3.9 L (95% CI: 3.7, 4.1), (P < 0.0001). Regarding VAT, the White participants had with 0.5 L (95% CI: 0.5, 0.6) VAT volume compared to0.3 L (95% CI: 0.3, 0.4) in Black participants (P < 0.0001) a higher VAT volume, while boys had with 0.5 L (95% CI: 0.4, 0.5) compared to 0.4 L (95% CI: 0.4, 0.4) in girls (P = 0.04) a higher VAT volume as well.

At reassessment after two years, the mean increase in FM was measured. In White adolescents, it was with 3.7 kg (95% CI: 2.9, 4.5) 2.3 kg (95% CI: 1.3, 3.3) higher than the increase in Black adolescents (P = 0.04). Girls had with 4.0 kg (95% CI: 3.0, 4.9) a higher increase in FM compared to 2.0 kg (95% CI: 1.1, 3.0) in boys (P = 0.007). Regarding SAT changes, no significant difference regarding race or sex was found. Nonetheless, the VAT increase was higher in Whites (0.1 L, 95% CI: 0.1, 0.1) than Blacks (0.0 L, 95% CI: 0.0, 0.1, P = 0.003), and in boys (0.1 L, 95% CI: 0.1, 0.1) than in girls (0.0 L, 95% CI: 0.0, 0.1, P = 0.034) (45).

A review Frank et al. from the USA examined in 2018 the determinants of adipose tissue distribution in humans and relevance to obesity-related health risks. While the study did not involve or show direct measurements, as a review it summarized the prior findings of cross-sectional and longitudinal studies, which used DXA, CT, and anthropometric indicators such as WC and WHR.

The study found that fat distribution varied significantly by sex in previous studies. On average, men had more abdominal VAT, while women accumulated more gluteofemoral SAT. After menopause, women experienced increased VAT accumulation similar to men. Regarding the determinants of adipose tissue distribution, they reported that estrogens promoted fat storage in the gluteofemoral SAT depot, while estrogen decline was associated with greater abdominal VAT mass. On the other hand, testosterone in men was associated with decreased gluteofemoral SAT and increased VAT deposition. They further showed that there were age-related changes in adipose tissue distribution, which included a shift from SAT to VAT accumulation in both sexes. Abdominal VAT increased through age 69 in both men and women, with the greatest increase observed in postmenopausal women. In contrast to the findings about differences VAT/SAT distribution in men and women, in older age groups there were no consistent sex difference in VAT mass observed (17).

Looking at sex differences, a Canadian study by Pan et al. from 2016 showed that for any BMI, men had higher lean mass, but more visceral and hepatic adipose tissue in comparison to women, who had on the other hand more general adiposity. This was demonstrated by a higher WC of 95.63 cm in men vs 86.65 cm in women at the same BMI. The data from the study were derived from the Canadian Health Measures Survey (2007-2011) and included 3.515 Canadian adults from 18-79 years of age (38).

In 2015, a review by Palmer and Clegg was published that examined sex-specific differences in adipose tissue distribution and their impact on metabolic health. They summarized that, in premenopausal women, fat is predominantly stored in subcutaneous depots, the gluteofemoral region in particular, which is associated with a lower risk of obesity-related complications. In contrast, men typically accumulate more visceral fat, contributing to a higher risk of cardiovascular disease. Following menopause, women experience a shift toward visceral fat accumulation, accompanied by an increase in metabolic risk like that observed in men (37).

As shown above, epidemiological studies have observed ethnic differences in body composition and adipose tissue distribution (50), however, the body of evidence in relation to specific adipose tissue distribution in terms of fat depots between different social groups is scarce, although it is known that SES inversely correlates with obesity (5)

In 2021, Staatz et al. published two systematic reviews in the International Journal of Obesity that were exploring the association between life course socioeconomic position and body composition in both childhood and adulthood. The studies considered, used different methods for measuring fat and lean mass such as bioelectrical impedance analysis and dual-energy X-ray.

For childhood, they observed in high-income countries a tendency for an association between socio-economic disadvantage and elevated body fat and a reduced lean mass. In middle-income countries lower socioeconomic position was generally associated with greater lower fat mass and lower lean mass. In high-income countries, 66% of the associations indicated that children from lower SES backgrounds had higher fat mass, while 55% of associations reported lower lean mass. In adulthood, higher socioeconomic status was most consistently associated with greater lean mass, with 100% of associations between income and appendicular skeletal muscle index showing a positive relationship. These patterns were also sex-specific: in high-income countries, 83% of associations among girls indicated that socioeconomic disadvantage was linked to higher fat mass, compared to 43% in boys. No consistent associations were found when fat-free mass was indexed to height. Parental education was the most used measure of childhood socioeconomic position, while education and income were predominant indicators in adulthood. Both reviews did not include any fat depot specific data (8).

7.2. Differences and similarities in the accumulation of subcutaneous adipose tissue between the social and demographic groups of patients with IHD

In 2025, Chagas et al. published the study “Different factors modulate visceral and subcutaneous fat accumulations in adults: a single-center study in Brazil”, which managed to incorporate social factors into their analysis and aimed to examine predictive factors associated with visceral and subcutaneous tissue accumulation. This was done via a cross-sectional study including 347 individuals (men and women) 20 years of age or older with a median age of 47 years, which were part of outpatient care in a public healthcare service in Northeast Brazil.

The method of choice for measuring visceral and subcutaneous tissue was ultrasound, additionally, other variables such as anthropometric, clinical, sociodemographic, and behavioral variables were implemented into the predictive model. The VAT and SAT measurements were assessed via ultrasound with the transducer being transversely positioned 1cm above the umbilicus (11).

Chagas et al. reported no absolute values in centimeters or volume but instead categorized visceral and subcutaneous fat thicknesses as increased or not. This categorisation of VAT/SAT obesity was based on predefined anatomical thresholds: ≥5.39 cm for VAT in men and ≥4.27 cm in women, and ≥2.83 cm for SAT in men and ≥3.68 cm in women. Based on these values as diagnostic cut-off points, obesity in SAT and VAT was defined.

The research revealed several key patterns in body fat distribution among adults under outpatient care with a high prevalence of increased VAT of 79.3%. Individuals who engaged in minimal physical activity were more prone to accumulating this type of internal fat, especially when paired with an elevated waist circumference (WC). Conversely, increased SAT was more often found in those who consumed alcohol (2.2 times higher odds of SAT accumulation with 95% CI 1.3–3.7 and $p = 0.005$) and had a larger WC (4.5 times higher odds with 95% CI 2.1–9.8 and $p < 0.001$).

Further distinctions emerged when comparing the VAT/SAT ratio, which measures both visceral fat accumulation and an individual's tendency to preferentially store fat viscerally. A higher proportion of VAT to SAT was more common in older individuals (≥60 years had 5.5 times the odds of a high VAT/SAT ratio with 95% CI 2.0–14.8), people identifying as Black (2.7 times higher odds and 95% CI 1.2–6.0) or of mixed racial background (2.0 times higher odds with 95% CI 1.1–4.1), those with fewer years of formal education (defined as ≤9 years and with OR 2.4; 95% CI 1.1–5.2 a significant predictor), and individuals living with diabetes (2.4 times greater odds with 95% CI 1.2–4.9) (11).

The main results were the observation that physical inactivity was an independent predictor of the visceral obesity phenotype. Meanwhile, subcutaneous abdominal obesity pattern was associated with alcohol consumption with a 50% reduced likelihood of having a high VAT/SAT ratio (OR 0.5; 95% CI 0.2–0.9). DM and sociodemographic characteristics, including older age, non-White race, and poorer education, were prognostic factors for a higher VAT/SAT ratio (11).

In a study published in *Obesity* (2011) by Camhi et al., researchers aimed to explore how waist circumference (WC) and body mass index (BMI) relate to specific fat compartments—namely, visceral adipose tissue (VAT), subcutaneous adipose tissue (SAT), and total fat mass (FM)—and whether these relationships differ by sex and race. The investigation included 1,667 adults aged 18 to 64 years, with participants stratified by race (White and African-American) and sex. Body composition was assessed using computed tomography (CT) for VAT and SAT, and dual-energy X-ray absorptiometry (DXA) for total fat mass (FM).

The results showed that WC and BMI were more strongly associated with FM and SAT than with VAT, regardless of sex or race. As an example, in the case of white women, BMI explained 84% (R^2 = 0.84) of the variance in FM, while it was only 52% (R^2 = 0.52) of the variance in VAT. Women, on average, had higher SAT (mean: 383.9 ± 137.6 cm^2) and FM (mean: 38.5 ± 12.7 kg) compared to men for equivalent WC or BMI values. VAT, in contrast, was more prominent in white participants than in African-Americans, especially at higher levels of adiposity. They reported that white men had a mean VAT area of 131.7 ± 59.2 cm^2, while African-American men had 114.7 ± 54.2 cm^2. These differences were most noticeable in the younger age group (18–39 years), while they tended to diminish with age. Moreover, the study found complex interactions: sex and race differences in fat depots were not uniform across all BMI or WC ranges. For example, while African-American men and women tended to have lower VAT than their white counterparts, this pattern became clearer at higher BMI levels (e.g., ≥30 kg/m^2) or WC levels above 102 cm in men and 88 cm in women (10).

In 2018, a study from the USA Schorr et al. assessed adipose tissue distribution and its relationship with cardiometabolic risk in 208 adults (94 men, 114 women) with overweight or obesity. For measurement of total and regional adipose tissue depots, they used dual-energy x-ray absorptiometry (DXA) and computed tomography (CT). In their measurements, they specifically compared VAT and SAT between sexes.

They reported that SAT was markedly higher in women compared to men. For thigh SAT, which was measured via CT at the mid-thigh level, significantly higher values were detected in women than in men (median 171 cm^2 [IQR: 136–233] vs. 128 cm^2 [IQR: 94–148]; $p < 0.0001$). Additionally, women had significantly more lower extremity fat mass by DXA (14 kg vs. 12 kg; $p = 0.001$), and a higher lower extremity fat to total fat ratio (0.38 vs. 0.33; $p < 0.0001$). These results were adjusted for age and BMI, the differences between men and women remained significant after adjustment. On the other hand, the results of the study showed that VAT was significantly higher in men (149 cm^2 [IQR: 122–208]) compared to women (106 cm^2 [IQR: 69–139]; $p < 0.0001$). The VAT/SAT ratio was also elevated in men (0.36 vs. 0.23; $p < 0.0001$), indicating a more centralized fat distribution.

Schorr et al. concluded that these findings indicate that despite similar BMI, men exhibit a pattern of fat distribution characterized by higher visceral adiposity, whereas women show greater subcutaneous and lower extremity fat accumulation. They also stated that visceral adipose tissue is more strongly associated with adverse cardiometabolic risk markers in women compared to men, while lower extremity fat is associated with more favourable metabolic profiles, which are more pronounced in women than in men (43).

Kammerlander et al. published their study “Sex Differences in the Associations of Visceral Adipose Tissue and Cardiometabolic and Cardiovascular Disease Risk: The Framingham Heart Study” in 2021 in *Journal of the American Heart Association,* using the data of the Framingham Heart Study with 3482 participants (48.1% women, mean age 50.8 ± 10.3 years).

Their aim was to determine whether anthropometric measures of adiposity as the BMI have the same prognostic value in cardiometabolic risk for men and women in comparison to more sophisticated methods such as measurement of subcutaneous adipose tissue and visceral adipose tissue by computed tomography since differences in fat distributions are known. Therefore, they compared the CVD risk based on CT versus anthropometric measures of fat with a mean follow-up of 12.7+-2.1 years. While VAT and BMI were similar in their relationship to cardiometabolic risk factors and CVD events in men, VAT showed in women a stronger association with both factors than BMI. VAT was significantly higher in men (2236 ± 1017 cm^3) compared to women (1364 ± 833 cm^3), while SAT was higher in women (3147 ± 1513 cm^3 vs. 2638 ± 1204 cm^3 in men). The VAT/SAT ratio was also higher in men (0.91 ± 0.38) compared to women (0.44 ± 0.21).

Kammerlander et al. concluded that while in men anthropometric measurements such as WC and BMI are sufficiently reflecting the VAT-related cardiometabolic and cardiovascular risk, this is not the case in women. In women, VAT and VAT/SAT ratio were significantly more predictive for incident diabetes (VAT OR: 4.51 [3.13–6.50] vs. BMI OR: 2.33 [1.88–3.04]), hypertension (VAT OR: 2.26 [1.80–2.84] vs. BMI OR: 1.74 [1.47–2.06]), and cardiovascular death (HR: 1.85 [1.26–2.71] vs. 1.19 [1.01–1.40]). Kammerlander et al. concluded that VAT measurement with CT is the more suitable approach to estimating obesity-related cardiometabolic and cardiovascular risk in women (28).

7.3. Differences and similarities in the accumulation of visceral adipose tissue between the social and demographic groups of patients with IHD

Obesity in western countries is strongly associated with social and socioeconomic factors particularly targeting individuals from lower socioeconomic background and socially disadvantaged groups (3). It is argued that socioeconomic status, defined as a “descriptive term for the position of persons in society, based on a combination of occupational, economic, and educational criteria which includes factors such as income, educational attainment, occupational prestige, and access to resources” (31) is a “key determinant” of obesity (5).

In a Spanish study published in 2025, Soler et al. examined how various sociodemographic and behavioral factors are linked to the accumulation of body fat—specifically, total body fat and visceral fat—in a large cohort of Spanish workers. The research sought to identify how elements such as age, sex, socioeconomic status, physical activity, and smoking habits influence fat distribution, with a focus on fat that contributes to cardiometabolic risk. Involving 8,590 participants (4,104 men and 4,486 women, mean age 41.6 ± 10.6 years for men and 41.5 ± 10.5 years for women), the cross-sectional study utilized bioelectrical impedance analysis with Tanita DC-430MA to quantify total body fat percentage and visceral fat level. The unit of measurement was visceral fat rating values of 10 or above indicated elevated visceral fat levels and were associated with increased cardiometabolic risk.

It should be noted that the study's main limitation is its focus on working-age individuals (18–69 years), excluding other age groups and unemployed populations. Additionally, since the sample is limited to Spain, the findings may not be generalizable to other populations.

In the discussion, they emphasized how age, sex, socioeconomic status, smoking, and physical activity all had a substantial impact on both total and visceral fat levels. Visceral fat rises with age and is more common in men, those from lower socioeconomic groups, smokers, and people who lead sedentary lives. Visceral fat in men rose from a mean of 3.4 (±2.9) in the 18–29 age group to 13.2 (±3.7) in the 60–69 group; in women, it increased from 2.1 (±2.2) to 8.4 (±3.3) across the same age groups. Smoking was linked to increased levels of visceral fat, highlighting its detrimental effects on fat distribution and a significantly higher mean visceral fat score compared to non-smokers (men: 8.0 vs. 7.8; women: 5.1 vs. 4.6).

The data demonstrated that body fat and visceral fat in particular tend to increase with age and are more prevalent among individuals with lower physical activity and lower social class. For example, in men from social class I (upper class), mean visceral fat rating was 7.0 (±4.6), while in class III (manual workers), it was 9.3 (±4.8); in women, the values were 3.5 (±2.6) and 6.2 (±3.6), respectively. Their research therefore showed a statistically significant increase in total body fat and visceral body fat with decreasing socio-economic status with the highest values in the lowest class III, assigned to manual workers, while class II, middle class, was intermediate vocations and self-employed individuals and class I managers, directors and university professionals, upper class (22: 3, 4).

Smokers also exhibited higher levels of both body fat and visceral fat. In multivariate regression, smoking was associated with a 19% higher odds of very high body fat (OR: 1.19; 95% CI: 1.10–1.29) and 29% higher odds of high visceral fat (OR: 1.29; 95% CI: 1.20–1.39), both $p < 0.001$. Through multivariate analysis, the study determined that advancing age and low physical activity levels were the strongest independent predictors of elevated total and visceral fat.

Individuals aged 60–69 years had 4.23 times the odds of very high body fat (95% CI: 3.33–5.14) and 45.39 times the odds of high visceral fat (95% CI: 27.04–63.74) compared to the youngest group. Those with low physical activity had 6.21 times the odds of very high body fat (95% CI: 5.17–7.26) and 7.58 times the odds of high visceral fat (95% CI: 6.05–9.12), both $p < 0.001$. The overall risk profile for excessive adiposity, particularly visceral fat, was characterized by being older, male, of lower socioeconomic background, physically inactive, and a smoker (22).

In 2024, the US-American ShapeUp! Kids Study by Maskarinec et al. assessed adipose tissue distribution in a sample of 303 children and adolescents aged 5 to 18 years, from which 170 were girls and 133 boys. They also were from five different ethnic groups: White, Black, Hispanic, Asian, and Native Hawaiian/Other Pacific Islander (NHOPI). The measurements of abdominal fat depots were taken by using magnetic resonance imaging (MRI) at four lumbar levels (L1–L5). The measured adipose tissue depots included SAT, VAT, and the VAT-to-SAT ratio. Additional variables such as muscle density and anthropometric data were also recorded.

In their results, Maskarinec et al. reported that the mean SAT was 178.8 ± 133.3 cm² in girls and 137.6 ± 143.6 cm² in boys ($p = 0.01$), while VAT was 39.2 ± 23.5 cm² in girls and 41.4 ± 34.8 cm² in boys, with no significant difference by sex. The VAT/SAT ratio was 0.26 ± 0.11 in girls and 0.40 ± 0.19 in boys ($p < 0.0001$). Muscle density was 0.91 ± 0.03 mg/cm³ in girls and 0.93 ± 0.03 mg/cm³ in boys ($p = 0.003$).

They acknowledged that the measurements of SAT, VAT, and VAT/SAT ratio differed significantly by ethnicity. First, the mean log-transformed VAT values were highest in White participants (3.64) and lowest in Asian participants (3.32). Furthermore, the mean log-SAT was highest in Black participants (4.98) and lowest in Asian participants (4.46). The VAT/SAT ratio was highest in Whites (−1.12) and lowest in Blacks (−1.56). Concludingly, the differences by ethnicity were statistically significant for SAT ($p = 0.02$), VAT ($p = 0.03$), and VAT/SAT ratio ($p < 0.0001$).

Furthermore, in the multivariable regression analyses, which were adjusted for age, BMI z-score, and waist circumference, there remained a significant association with Black race having lower VAT compared to White participants. Finally, the estimated regression coefficient for VAT in Black vs. White girls was −0.34 (95% CI: −0.49 to −0.19) and for boys −0.29 (95% CI: −0.48 to −0.09). Model R^2 values were higher for SAT (0.88 in girls, 0.73 in boys) than for VAT (0.66 in girls, 0.65 in boys) (33).

7.4. Differences and similarities in the accumulation of cardiac (epicardial, pericardial, paracardial, perivascular) adipose tissue between the social and demographic groups of patients with IHD

The study by Shah et al. (2017), published in *JACC: Cardiovascular Imaging*, was concerned with sex- and ethnicity specific patterns of accumulation of cardiac adipose tissue, and examined the associations between pericardial fat and cardiovascular structure, function, and clinical outcomes using data from the Multi-Ethnic Study of Atherosclerosis (MESA).

Included into the study were 4,234 individuals from racially and ethnically diverse backgrounds (White, African-American, Hispanic, and Chinese-American). The method was cardiac CT to measure pericardial fat and CT/MRI for cardiac structure and function, including hepatic fat quantification.

Significantly, pericardial fat was independently associated with increased risk of unfavorable cardiovascular outcomes, such as coronary heart disease and heart failure. This was even after adjustment for conventional risk factors, markers of insulin resistance, and systemic inflammation. Furthermore, increased pericardial fat was also associated with left ventricular hypertrophy and concentric remodeling, indicating its potential impact on cardiac structure.

Demographic differences were also evident across quartiles of pericardial fat volume. Quartile 1 included values from 4.15 to 29.28 cm^3/m, Quartile 2 from 29.29 to 41.46 cm^3/m, Quartile 3 from 41.46 to 56.80 cm^3/m, and Quartile 4 from 56.81 to 194.38 cm^3/m. African-American participants comprised 36% of Quartile 1 and only 13% of Quartile 4, whereas White participants increased from 24% in Quartile 1 to 30% in Quartile 4. Hispanic participants also showed a marked rise, from 15% in Quartile 1 to 34% in Quartile 4. Chinese-American participants were more evenly distributed across quartiles, ranging from 19% to 30%. Age also increased across quartiles, with median ages of 55, 59, 63, and 65 years in Quartiles 1 through 4, respectively ($p < 0.01$).

Moreover, the study identified sex- and ethnicity-specific patterns: women had greater associations of pericardial fat with left ventricular mass and end-diastolic volume, while African-American subjects had greater reductions of left ventricular ejection fraction with increasing levels of pericardial fat (44).

In their paper “Epicardial Adipose tissue: Clinical Biomarker of Cardio-Metabolic Risk” from 2019, Fricke and Iacobellis summarized previous research about racial and ethnic differences in epicardial adipose tissue. According to their research, there are racial and ethnic differences in EAT thickness in people with and without metabolic syndrome. Other previous studies on the association between epicardial adipose tissue and metabolic syndrome reported that differences in EAT thickness between individuals with and without metabolic syndrome were most pronounced in Caucasian populations, trailed by Hispanic, Turkish, and Asian groups (47).

They also reported about a study from Salami et al. in 2013, which examined 150 patients admitted to a clinical decision unit for chest pain and looked at racial differences in epicardial adipose tissue (EAT) thickness. For their measurement, they used a two-dimensional transthoracic echocardiography. The epicardial fat thickness was measured at the mid right ventricular wall and was examined how it related to anthropometric variables (BMI and percent body fat). T

In their analysis, they presented the findings that anterior EAT thickness was significantly greater in non-Hispanic White Caucasians compared with non-Hispanic Black African-Americans, both in men (4.9 ± 2.1 mm vs. 3.8 ± 1.8 mm) and in women (5.8 ± 3.2 mm vs. 3.7 ± 1.7 mm). This difference persisted after adjusting for age, sex, BMI, and waist circumference, as well as for percent body fat. Regression analysis confirmed that race remained a significant independent predictor of epicardial fat, even when controlling for other body composition measures (41).

An Australian study by Adams et al. from 2017 examined differences in EAT and coronary plaque using coronary tomography. Included into the study were 150 participants from a mixed ethnic background: 50 South Asians, 50 Southeast or East Asians (SEAA) and 50 Caucasians, which were matched for the factors age, gender and BMI. Methodically, they used a 320-row multi-detector coronary angiography, which enabled them to quantify epicardial fat volume (EFV) and aggregate plaque volume (APV) in the first 5cm of the left anterior descending artery (LAD).

They reported in their findings that both South Asian and SEAA had a significantly higher EFV in comparison to Caucasians. In numbers, EFV measured 103.2 ± 41.7 cm^3 in South Asians, 110.8 ± 36.9 cm^3 in SEEAs, and 85.8 ± 39.4 cm^3 in Caucasians ($P = 0.006$). When normalized as a percentage, EFV was similar in both Asian groups (14.4 ± 5.7% in South Asians, 13.9 ± 5.2% in SEEAs) and significantly lower in Caucasians with 10.1 ± 4.6% ($P < 0.001$).

Concludingly, South Asians exhibited with a percentage APV of 44.5 ± 8.4% the highest burden of coronary plaque. In pomparison, the percentage APV was in SEEAs 37.5 ± 6.5% and 39.5 ± 6.4% in Caucasians ($P < 0.001$). Furthermore, multivariate regression showed that South Asian ethnicity was the strongest independent predictor of plaque burden in the LAD ($P < 0.000002$), above traditional risk factors such as hypertension, diabetes, and statin use (2).

In a previous comparison between Asian and Caucasian populations from 2014, El Khoudary et al. observed a higher EFV in Japanese migrants living in the United States when compared to Caucasian Americans. In their study, they examined 1.199 participants (middle-aged men, 24.2% Caucasians, 7.0% African-Americans, 23.6% Japanese-Americans, 22.0% Japanese, 23.2% Koreans) based on BMI, CT-measured ECF volumes (epicardial, pericardial and their summation) and VAT. They found that Caucasians had the highest VAT (162.2 ± 116.4 cm^2), while Koreans had the lowest VAT (126.6 ± 99.7 cm^2). EAT was greatest in Japanese-Americans (51.9 ± 37.1 cm^3) and lowest in Koreans (43.5 ± 14.5 cm^3). PAT was highest in Japanese-Americans (16.2 ± 8.7 cm^3) and lowest in Koreans (10.0 ± 6.1 cm^3). Similar trends were observed for total heart fat.

Additionally, supporting analyses showed that VAT generally predicted ectopic fat more strongly than BMI, especially in African-Americans and Japanese-Americans. The strength of these associations varied across ethnicities: While in Koreans, VAT was significantly less predictive of all fat depots (e.g., $\beta = -0.26$ for EAT, $p < 0.001$), BMI had a weaker association with cardiac fat in African-Americans (16).

The Finnish study "Determinants of echocardiographic epicardial adipose tissue in a general middle-aged population – The Cardiovascular Risk in Young Finns Study" by Gustafsson et al. from 2024 published in *Scientific Reports* by Nature examined a multitude of factors as determinants of epicardial adipose tissue measured by echocardiography. These factors included cardiometabolic, nutritional, lifestyle as well as socioeconomic parameters. Additionally, gender-specific differences were also looked at.

Methodically, they based their research on the cohort of the "Cardiovascular Risk in young Finns Study" from 2011 and had 1667 participants with the age of 34-49 years, consisting out of 770 men and 897 women). The EAT thickness was measured via transthoracic echocardiography in the parasternal long-axis view. The mean EAT thickness was 4.07 ± 1.53 mm, with 3.99 ± 1.44 mm in men and 4.14 ± 1.60 mm in women ($p = 0.08$). The data analysis conducted with multivariable linear regression models.

As results, they could show that independent predictors of EAT-thickness were female sex (+11.0%, $p < 0.0001$), type 2 diabetes (+14.0%, $p = 0.028$), waist circumference ($\beta = 0.38$ per cm, $p < 0.0001$), systolic blood pressure ($\beta = 0.18$ per mmHg, $p = 0.026$), and red meat intake ($\beta = 0.02$ per g/day, $p = 0.05$). As gender-specific differences they found for women a positive association between EAT and age, alcohol intake, heavy drinking ($\beta = 30.48\%$, $p < 0.0001$), and type 2 diabetes. In comparison to men, after the age of 46 there was a significant elevation of EAT thickness in women shown by a significant age-by-sex interaction ($p = 0.002$).

Mean EAT thickness increased across age from 3.81 mm (ages 34–39) to 4.32 mm (ages 45–49). This pattern was primarily observed in female participants. For men, there was an inverse association between EAT-thickness and fruit intake ($\beta = -0.10$ per g/day, $p = 0.04$) (21).

In 2023, a study by Ma et al. from the Netherlands, China and the USA, titled “Relationships of pericoronary and epicardial fat measurements in male and female patients with and without coronary artery disease,” investigated the association between pericoronary adipose tissue mean attenuation (PCATMA, a CT-derived marker reflecting local coronary inflammation based on fat tissue density) and EAT measurements in individuals with and without CAD In the study, 266 patients were included, of which 185 had no CAD and 81 had CAD, with 86.4% of the CAD group exhibiting stenosis >50%. The measurements were obtained by coronary computed tomography angiography (CCTA), and comparisons were made across sex, CAD status, and cardiovascular risk factors. The units used for the measurements of PCATMA and EAT density were Hounsfield Units (HU) and EAT volume in cm^3.

In terms of sociodemographic findings, men had significantly greater EAT volumes than women across both CAD and non-CAD groups. In non-CAD participants, the EAT volume was 174.4 ± 69.1 cm^3 in men compared to 124.1 ± 57.3 cm^3 in women. In CAD participants, the values were 193.6 ± 62.5 cm^3 for men and 148.5 ± 50.5 cm^3 for women ($p < 0.05$). Looking at EAT density, for the non-CAD group, EAT density was slightly lower in men than in women (-96.4 ± 6.3 HU vs. -94.4 ± 5.5 HU, $p < 0.05$), while in the CAD group, both sexes had similar EAT density (−98.2 HU). Regarding PCATMA, the values in men were higher (i.e. less negative) than in women in both groups. In non-CAD participants, PCATMA was -92.5 ± 10.6 HU in men and -96.2 ± 8.4 HU in women; in CAD patients, -92.2 ± 9.0 HU in men and -97.4 ± 9.7 HU in women ($p < 0.05$), indicating relatively more inflamed fat tissue in males.

PCATMA and EAT density were strongly correlated in both CAD ($r = 0.686$, $p < 0.001$) and non-CAD ($r = 0.725$, $p < 0.001$) groups. No significant correlation was found between PCATMA and EAT volume (Pearson correlation efficient $r = 0.018$, $p = 0.81$ in non-CAD; $r = -0.055$, $p = 0.63$ in CAD). A weak inverse relationship existed between EAT volume and EAT density (non-CAD: $r = -0.244$, $p < 0.001$; CAD: $r = -0.263$, $p = 0.02$).

Multivariate linear regression showed that EAT density was consistently associated with PCATMA across all patient subgroups and models ($p < 0.001$), whereas EAT volume showed no significant association with PCATMA after adjusting for covariates such as age, cardiovascular risk, and CT tube voltage. The study concluded that while PCATMA and EAT density were closely related, EAT volume was not a strong correlate, and their association varied by sex and disease status (32).

In the 2025 study titled "Correlation analysis between epicardial adipose tissue and acute coronary syndrome" by Zhihong et al. from China investigated the correlation between the density and volume of epicardial adipose tissue (EAT) and acute coronary syndrome (ACS). Epicardial adipose tissue volume (EATV) and epicardial adipose tissue density (EATD) were measured using coronary computed tomography angiography (CCTA) with EATV measured in cm^3 and EATD in HU.

Included into the study were a total of 192 patients in matched groups with 96 in the ACS group and 96 in the non-ACS group of whom 120 were men (62.5%) and 72 were women (37.5%). Further characteristics of the patients were a mean age of 64.44 ± 10.03 years in the ACS group and 63.32 ± 9.83 years in the non-ACS group ($p = 0.451$). The mean BMI was 25.06 ± 2.85 kg/m^2 in the ACS group and 24.02 ± 2.76 kg/m^2 in the non-ACS group ($p = 0.012$). The mean age of participants was 64.44 ± 10.03 years in the ACS group and 63.32 ± 9.83 years in the non-ACS group ($p = 0.451$).

Zhihong et al. reported in their results that the mean EATD in the ACS group was −95.9 ± 11.12 HU, and in the non-ACS group −111.6 ± 11.48 HU ($p < 0.001$). The median EATV in the ACS group was 124.98 cm^3 with an interquartile range (IQR, range between the 25th percentile (Q1) and the 75th percentile (Q3) of a dataset) of 109.76–136.81 cm^3, while in the non-ACS group it was 114.46 cm^3 (IQR: 108.00–124.30 cm^3) ($p < 0.001$). No statistically significant differences in EATV or EATD between male and female participants were reported in the matched groups. Data on ethnicity were not presented.

Regarding the aim of the study, binary logistic regression analysis showed that both EATD (OR = 6.942; 95% CI: 3.875–12.437) and EATV (OR = 1.892; 95% CI: 1.211–2.955) were independent risk factors for ACS (51).

The English study by Miller and Steptoe from 2023 "Pericardial Fat, Socioeconomic Status, and Biological Responses to Acute Mental Stress" published in Psychosomatic Med. examined whether there are associations between PAT and SES. This was due to the observation that PAT is engaged in the pathogenesis of CVD, but evidence for an association between PAT and cardiovascular and inflammatory response due to mental stress is scarce. The objective of the study was therefore to examine, if there is any influence of socioeconomic status on pericardial fat volume and if PAT can predict biological stress responses.

Methodically, the study was composed of 473 healthy men and women with a mean age of 62.8 ± 5.7 years, 60.3% male. The classification of SES was derived from grade of employment withing the British civil service and put into 3 categories: higher (39.3%), intermediate (40.0%) and lower (20.7%). The volume of PAT was quantified by electron bean CT with adjustment for body surface area. The mean adjusted pericardial fat volume was 62.08 ± 22.99 cm^3/m^2 for both sexes. Comparing sex, men showed significantly higher values of PAT volume (66.13 ± 22.69 cm^3/m^2) compared to women (55.74 ± 21.38 cm^3/m^2, $p < 0.001$). The cardiovascular and inflammatory responses to laboratory-induced mental stress were assessed by a 5-minute Stroop task and 5-minute mirror tracing task. Meanwhile, cardiovascular and inflammatory parameters were measured.

Miller and Steptoe's results showed an association of PAT with a range of relevant factors in CVD such as higher resting heart rate ($\beta = 0.082$, $p < 0.001$), lower heart rate variability ($\beta = –0.004$, $p = 0.001$), and higher levels of IL-6, fibrinogen, and CRP. Notably, PAT volume did not vary by socioeconomic status across all employment categories. Additionally, the factor SES did not influence any on the associations between PAT and physiological stress responses (35).

The study "Pericardial adipose tissue and the metabolic syndrome is increased in patients with chronic major depressive disorder compared to acute depression and controls" by Kahl et al. from Germany and the UK in 2017, examined whether pericardial adipose tissue (PAT) is elevated in individuals with chronic major depressive disorder (MDD) compared to those with acute MDD and healthy controls. It included 16 patients with chronic MDD, 34 with acute MDD, and 25 healthy controls. In the study, PAT was measured by cardiac MRI. Kahl et. al observed that PAT volume was significantly higher in the chronic MDD group compared to both the acute MDD and control groups ($P < 0.001$). Patients with acute MDD also showed higher PAT than controls ($P = 0.049$).

PAT volume was not reported in exact numerical values by Kahl et al. (2017), but Figures 6 and 7 visually demonstrated distinct group differences. As can be seen in Figure 6, PAT appeared to be increased in patients with MDD compared to those with acute MDD and healthy controls. A gradual and stepwise increase from controls to acute MDD to chronic MDD was visually evident. In Figure 7 this pattern was consistent when stratified by sex: in both female and male patients with chronic MDD greater PAT volumes were visible in comparison to their respective control and acute MDD counterparts. Regarding acute MDD, across both sexes intermediate PAT volumes could be seen, while the participants from the control group had the lowest PAT volume. As written in the description of the figures, these graphical trends were corrected for age, height, and weight, and statistically significant differences were indicated between the groups.

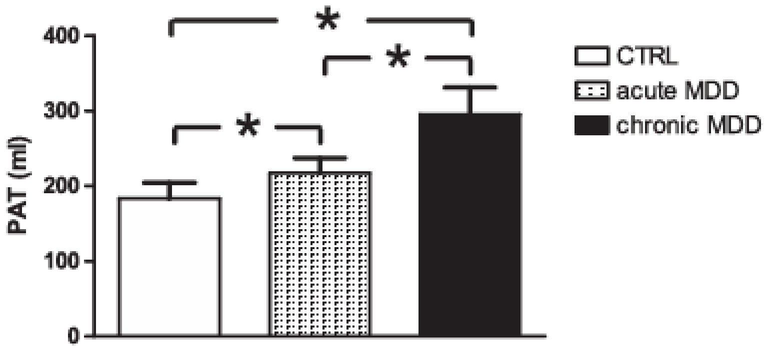

Fig. 1. Pericardial adipose tissue (PAT) was enlarged in patients with chronic MDD compared to acute MDD and CTRL, and in patients with acute MDD compared to CTRL. Bars are presented as mean ± SD, corrected for age, height and weight. A *P*-value of <0.05 was considered significant.

Figure 5: Graph showing PAT (ml) in CTRL, acute MDD and chronic MDD by Kahl et al. 2017

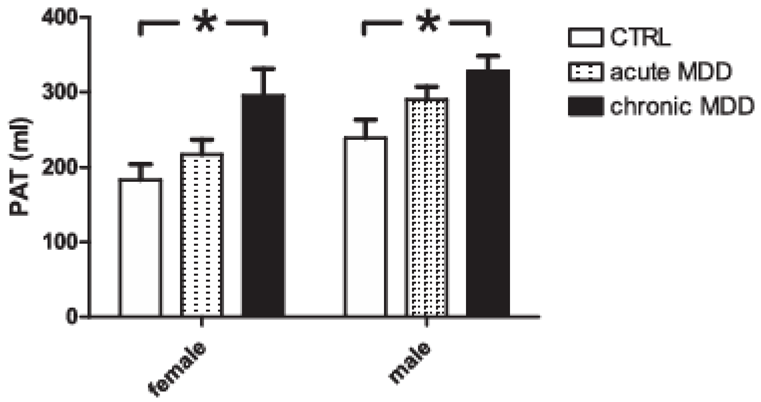

Fig. 2. Pericardial adipose tissue (PAT) was increased in female patients with chronic MDD > females with acute MDD > CTRL, and in males with chronic MDD > males with acute MDD > CTRL. Bars are presented as mean ± SD, corrected for age, height and weight. A *P*-value of <0.05 was considered significant.

Figure 6: Graph showing PAT (ml) in CTRL, acute MDD and chronic MDD separated by sex by Kahl et al. 2017

Stratified analyses revealed that both male and female patients with chronic MDD had significantly greater PAT than sex-matched controls (P = 0.015 for males, P = 0.012 for females) (26).

Kahl et al. already previously demonstrated in a different study that, after controlling for age, weight, height, and physical activity, individuals with major depressive disorder (MDD) exhibited higher volumes of pericardial adipose tissue compared to healthy controls (27).

In a 2018 study featured in *Acta Radiologica*, Gill explored how pericardial adipose tissue (PAT) correlates with cardiometabolic risk, with a specific focus on differences between sexes due to the broader context of CVDs being more prevalent in men, but with higher fatality rates in females. Therefore, Gill examined variations in fat distribution, particularly in PAT, and their potential role in explaining these gender disparities in health outcomes.

The study analyzed 303 adults (151 women and 152 men, mean age 56 ± 17 for women and 54 ± 17 for men) with diverse body weights. Using computed tomography (CT) from routine PET/CT scans, they assessed pericardial adipose tissue, visceral adipose tissue (VAT), and subcutaneous adipose tissue (SAT). Additionally, they gathered standard cardiometabolic risk factor data from participants' medical records such as glucose, lipids and blood pressure values. To explore the relationship between PAT and health indicators, they used linear regression, correlation analysis and ROC curve analysis.

The results showed that men had significantly higher PAT volumes (19 ± 10 cm^2) compared to women (15 ± 9 cm^2, $p = 0.0005$). Additionally, VAT was greater in men (138 ± 78 cm^2) than in women (106 ± 70 cm^2, $p = 0.0002$), while SAT was higher in women (268 ± 138 cm^2) than in men (233 ± 117 cm^2, $p = 0.02$). Abdominal circumference was also greater in men (97 ± 13 cm) than women (94 ± 15 cm, $p = 0.03$), and fasting glucose levels were higher in men (115 ± 28 mg/dL) versus women (109 ± 21 mg/dL, $p = 0.04$). Notably, HDL cholesterol was considerably lower in men (42 ± 16 mg/dL) than in women (61 ± 21 mg/dL, $p < 0.0001$). Notably, PAT was positively associated with various cardiometabolic risk markers such as BMI, abdominal fat, fasting glucose, and lipid levels. It had stronger associations observed in women. PAT also demonstrated moderate diagnostic accuracy for detecting metabolic syndrome (AUC = 0.80), with 74% sensitivity and 76% specificity (19).

8. Discussion

This discussion synthesizes findings from the reviewed studies structured by the objectives to examine how the distribution of subcutaneous, visceral, and cardiac (epicardial, pericardial, paracardial and perivascular) adipose tissue varies across sex, age, ethnicity, and socioeconomic groups in individuals with ischemic heart disease.

8.1 Objective 1: Subcutaneous Adipose Tissue (SAT) in Social and Demographic Groups

Sex Differences

Across a wide range of studies, significant differences based on sex were shown in adipose tissue distribution. Men possessed higher VAT volume in comparison to women, while women had higher SAT volume.

In the study by Schorr et al. (2018), VAT in men was measured at a median of 149 cm^2 compared to 106 cm^2 in women. Conversely, women had higher SAT with a median value of 171 cm^2 compared to 128 cm^2 in men (43). Kammerlander et al. used MRI and quantified VAT and SAT in volume (cm^3). Similarly, SAT was higher in women (3147 ± 1513 cm^3) than in men (2638 ± 1204 cm^3) (28). Frank et al. supported this observation in his review and reported similar sex-specific distribution patterns of adipose tissue (17). This pattern was particularly prominent before menopause, where women tended to store more fat subcutaneously. Post-menopausal women experienced a visceral fat increase shifting their distribution from SAT to VAT, leading to higher metabolic and cardiovascular risk (37).

These hormonal changes underscore the importance of depot-specific risk assessment in women. Furthermore, the ShapeUp! Kids study by Maskarinec et al. found that SAT was significantly higher in girls (178.8 ± 133.3 cm^2; $p < 0.0001$) than boys.

Ethnic Differences

Staiano and Katzmarzyk used MRI to assess SAT and VAT and found SAT was higher in girls across both Black and White youths (45).

Maskarinec et al. reported SAT was highest in Black children, while VAT and VAT/SAT ratios were highest among Whites. These differences were statistically significant for SAT ($p = 0.02$), VAT ($p = 0.03$), and VAT/SAT ratio ($p < 0.0001$) (33).

These findings suggest that ethnic differences in SAT appear early in life, potentially due to both genetic and environmental exposures.

Socioeconomic factors

No consistent findings regarding socioeconomic differences in subcutaneous adipose tissue were reported across the reviewed studies, suggesting these associations remain underexplored or inconclusive. Regarding lifestyle factors, Chagas et al. found that alcohol intake was associated with higher SAT (11).

8.2 Objective 2: Visceral Adipose Tissue (VAT) in Social and Demographic Groups

Sex Differences

Men consistently had higher VAT volumes than women. In Schorr et al. (2018), VAT was 149 cm^2 in men vs. 106 cm^2 in women (43), and in Kammerlander et al., 2236 ± 1017 cm^3 vs. 1364 ± 833 cm^3 (28).

Frank et al. described an age- and hormone-dependent (postmenopausal) shift, leading to increased visceral fat accumulation in postmenopausal women and consequently elevating cardiometabolic risk (17; 37). This fat redistribution may partially explain why women's cardiometabolic risk sharply increases after menopause and highlights the importance of life-course assessment.

Ethnic and Racial Differences

Yaghootkar et al. found Black individuals had less VAT than Europeans, yet similar or higher metabolic risk; South Asians had higher cardiometabolic risk despite lower BMI (50; 49).

Maskarinec et al. showed VAT was highest among White children, while Black children had higher SAT (33).

Xu et al. used NHANES data and reported that VAT increased by 6.4 cm^2 per BMI unit in Whites, 6.04 in Asians, 5.63 in Hispanics, and only 3.79 in Blacks, which indicates that at equivalent BMI levels, white participants had substantially more visceral fat that their black counterparts. The WC–VAT slope was also strongest in Whites ($\beta = 2.85$) and weakest in Blacks ($\beta = 1.75$), showing differences in adipose tissue distribution based on race and ethnicity, independent of BMI (49).

Staiano and Katzmarzyk used MRI to assess SAT and VAT volumes and reported greater VAT volumes in White youths (0.5 L) compared to Black counterparts (0.3 L; $p < 0.0001$) (45).

The presented studies showed considerable variations in VAT accumulation across racial and ethnic groups, supporting the inadequacy of BMI as a universal cardiometabolic risk indicator and highlighting the need for ethnically adjusted thresholds.

Age Differences

Frank et al. used cross-sectional and longitudinal data from imaging-based studies and documented that VAT levels increased with age in both sexes until approximately 69 years, with postmenopausal women showing the most pronounced increases (17).

Soler et al. came to similar results by using bioelectrical impedance analysis (BIA) in a large adult population and reported that visceral fat rating increased with age. In men, VAT rating rose from a mean of 3.4 (±2.9) in the 18–29 age group to 13.2 (±3.7) in those aged 60–69. In women, values increased from 2.1 (±2.2) to 8.4 (±3.3) over the same age range (22).

These combined findings suggest age as a strong, independent predictor of VAT accumulation.

Socioeconomic Status (SES)

Soler et al. showed by bioelectrical impedance analysis that individuals from the lowest socioeconomic group showed higher mean VAT rating values of 9.3 ± 4.8 in men and 6.2 ± 3.6 in women, compared to 7.0 ± 4.6 in men and 3.5 ± 2.6 in women in the highest SES group ($p < 0.001$). Values of 10 or above indicated elevated visceral fat levels and were associated with increased cardiometabolic risk. While mean values in both groups remained below the clinical threshold, these differences indicated a trend toward higher VAT accumulation in the lower socioeconomic groups (22).

Chagas et al., using ultrasound, found that lower education (≤9 years), physical inactivity, older age (≥60 years) and non-white skin color were linked to higher VAT/SAT ratios, while similarly to the findings by Soler et al. individuals with higher education showed a lower ratio (11). Staatz et al found in their systematic reviews that childhood and adulthood adiposity were higher in individuals from lower SES backgrounds especially in females and in high-income countries, although they did not specify adipose tissue depots (8).

Regarding lifestyle and behavioural factors, Soler et al. reported an association between smoking (OR 2.68) and inactivity (OR 7.58) to higher VAT ($p < 0.001$), while Chagas et al. added associations with diabetes and older age (22; 11).

These findings represent robust evidence that social disadvantage is not only linked to general obesity but is also associated with more harmful fat distribution patterns and lifestyle/ behavioural factors, indicating a need for more research into how social disadvantage translates into biological risk in terms of negatively influencing adipose tissue accumulation.

8.3 Objective 3: Cardiac Adipose Tissue (EAT, PAT, Paracardial, Perivascular) in Social and Demographic Groups

Sex Differences

There was consistent reporting of sex differences: Ma et al. found that men had significantly larger epicardial fat volumes than women, both in patients with and without coronary artery disease (CAD), with values of 193.6 ± 62.5 cm³ vs. 148.5 ± 50.5 cm³ in CAD cases (32). Similarly, Miller and Steptoe found that men had higher indexed PAT volumes (66.13 ± 22.69 cm³/m²) than women (55.74 ± 21.38 cm³/m², $p < 0.001$) (35). This gender disparity was further supported by Gill et al., who found that men's PAT volumes were 19 ± 10 cm² while women's were 15 ± 9 cm² ($p = 0.0005$).

Ethnic and Racial Differences

Shah et al. observed via cardiac MRI measurement that Whites and Hispanics had significantly greater PAT volumes than African-Americans (44). Similarly, El Khoudary et al. reported by assessment via CT the highest EAT volumes in Japanese-Americans (51.9 ± 37.1 cm³) and the lowest in Koreans (43.5 ± 14.5 cm³) (16). Adams et al. also used CT and identified greater EAT volume in South and Southeast Asians (103.2 ± 41.7 cm³ and 110.8 ± 36.9 cm³, respectively) compared to Caucasians (85.8 ± 39.4 cm³; $p = 0.006$) (2). Finally, Salami et al. (2013) found greater anterior EAT thickness in White men (4.9 ± 2.1 mm) and women (5.8 ± 3.2 mm) compared to their Black counterparts (3.8 ± 1.8 mm and 3.7 ± 1.7 mm, respectively). These ethnic variations suggest that specific reference ranges for cardiac fat may be necessary for more suitable risk prediction.

Age Differences

Gustafsson et al. found by using transthoracic echocardiography that EAT thickness increased with age in women, from 3.81 mm (age 34–39) to 4.32 mm (45–49), with a significant age-by-sex interaction ($p = 0.002$), suggesting that age-related increases in EAT were more pronounced in women (21). Similarly, Shah et al. showed that pericardial fat volume increased progressively with age in the MESA cohort, with median ages rising from 55 to 65 years across ascending quartiles (44). The articulated age-related increases in cardiac fat depots imply their relevance as early risk markers for cardiovascular risk assessment via imagining, especially in middle-aged adults.

Socioeconomic Status

The study by Gustafsson et al., which used echocardiography in the Young Finns cohort, found an association between lifestyle factors and epicardial adipose tissue (EAT), which differed by sex. In women, heavy alcohol consumption was associated with an increase in EAT thickness. In men, greater fruit intake was inversely associated with EAT. EAT was also elevated in individuals with type 2 diabetes and elevated systolic blood pressure (21). In contrast to Gustafsson et al., Miller and Steptoe analysed PAT with cardiac MRI, but found no association between SES (based on employment grade) and PAT volume (mean PAT: 62.08 ± 22.99 cm^3/m^2). In their analysis, PAT was positively linked to inflammatory markers such as IL-6 and CRP, but SES did not moderate this effect (35). There may also be a connection between psychological vulnerability and cardiac fat accumulation. Kahl et al. discovered that patients with chronic major depressive disorder had higher PAT volumes than patients with acute MDD or healthy controls (26).

These findings suggests that socioeconomic, lifestyle as well as clinical factors might influence EAT and PAT, though conflicting research highlights the need for further study of how social disadvantage as well as behavioural and lifestyle factors are associated with cardiac fat accumulation.

Regarding paracardial and perivascular fat depots, no studies meeting the inclusion criteria reported social or demographic differences specifically, emphasizing either a lack of research into these less-studied cardiac adipose tissue compartments or reflecting a lower scientific and clinical relevance.

8.4 Limitations

During the process of literature research, several limitations were encountered, which are addressed to provide context for the findings of this narrative literature review. The interdisciplinary nature of the topic made it challenging to find suitable literature that includes and combines the specific aspects of the research question.

As a result, studies presented in the review stem from different research domains and are only suitable to answer a part of the research question. As an example, a wide body of research exists regarding differences in adipose tissue accumulation by race and ethnicity, but many studies do not specifically examine it in context of IHD. Nevertheless, studies of such kind were included due to their relevance in demonstrating differences in adipose tissue distribution by sociodemographic factors. This highlights a gap in the literature since there is a lack of studies that simultaneously consider all aspects embedded into the aim of the thesis: fat depot distribution, sociodemographic characteristics and IHD.

Another methodological challenge that was encountered was the considerable heterogeneity in the methodology of included studies for example studies about socioeconomic status and its impact on adipose tissue accumulation focused on BMI and central obesity without specifically measuring or discriminating between SAT and VAT. Some studies assessed fat depots with different modalities such as CT, MRI, ultrasound, bioelectrical impedance analysis etc. and measured the thickness of fat depots in cm, while others looked at the volume. This mentioned heterogeneity leading to different measurement modalities and units makes direct comparison between those studies challenging.

A further important methodological limitation was the widespread reliance on traditional anthropometric measures such as body mass index and waist circumference by many studies. While these are commonly used in clinical and population studies, they do not adequately distinguish between subcutaneous, visceral, or ectopic fat depots. This reliance on non-specific anthropometric proxies limits the accuracy and comparability of many findings and may contribute to underestimation of cardiometabolic risk in vulnerable populations.

One potential limitation of this review is the possibility of selection bias. The studies included into the review might disproportionately represent certain populations, research settings, or publication tendencies and therefore limit the generalizability of the findings to broader or more diverse cohorts. This is evidenced by the heterogeneity in study populations and the setting in which research was conducted. The studies that were included into the review were conducted in various countries as the USA, Spain, Brazil, Finland among others. This represents a limitation since each country has its own individual healthcare system and different societal contexts and structures, which has influence on fat distribution patterns and the operationalization and measurement of sociodemographic variables. One example is the comparison made between the Spanish working population studied by Soler et al. (2025) and the Brazilian outpatient cohort in Chagas et al. (2025). The differences in socioeconomic categorization, health behaviours and the population itself are limiting the validity of the findings derived from the comparison.

Furthermore, most studies were cross-sectional, limiting conclusions about causality and the long-term influence of social factors on fat accumulation. It proved difficult to find relevant literature in all areas of this thesis that was published within the last 5-10 years. Therefore, relevant literature was included irrespective of its age, if the findings were relevant to this thesis and contributed towards representing the current state of research.

The use of Mesh-Terms showed in the methodology for the purpose of research in online libraries such as PubMed proved to be exhaustive in some areas due to very limited results for visceral adipose tissue and no results for the different cardiac adipose tissues, when trying to include all aspects of the aim of this thesis, which emphasizes the research gap.

Another factor was the heterogeneity in terminology, for example VAT-related studies might be indexed under “intra-abdominal fat.” Similarly, regarding cardiac fat depots, epicardial, pericardial, and paracardial fat are often used interchangeably or inconsistently. These various aspects about including different variations of MeSH-Terms led to results that were either too broad and did not serve the purpose of identifying relevant studies anymore or too little results.

Nonetheless, by making use of citation network tools provided by PubMed, cross-referencing and consistent refinement of research process as well using google Scholar with the key words mentioned in the beginning of the thesis, it was possible to identify suitable literature.

9. Conclusion

1. Women more often than men exhibit higher levels of subcutaneous adipose tissue, especially before menopause. Higher subcutaneous adipose tissue levels were found among Black adolescents. Asian populations tended to have lower levels of subcutaneous adipose tissue, while White individuals showed higher levels than Asians, but lower levels than Black individuals. Evidence about the depots of subcutaneous tissue among the Hispanic population was mixed. Socioeconomic status appeared to have only a modest relationship with subcutaneous adipose tissue distribution. Lifestyle factors such as alcohol consumption were associated with higher subcutaneous adipose tissue levels in some populations.
2. Men, postmenopausal women and individuals with lower socioeconomic status have been found to have higher visceral adipose tissue levels. Lower educational attainment was associated with increased visceral adipose tissue. Older age was a consistent predictor of increased visceral adipose tissue accumulation across studies, reflecting age-related fat redistribution. Asians exhibited higher visceral adipose tissue at lower body mass index thresholds, while African Americans tended to have lower visceral adipose tissue, but similar metabolic risk.
3. Men exhibited higher volumes of both epicardial and pericardial adipose tissue than women, though some studies reported stronger cardiometabolic associations of pericardial fat in women. Both epicardial and pericardial adipose tissue volumes increased with age, indicating age-related shifts in cardiac fat accumulation. Epicardial adipose tissue volumes were higher among South and East Asians and Whites compared to Black individuals. Associations with lifestyle and other factors such as alcohol intake, hypertension and diabetes were observed. Psychosocial stress and mental health conditions may influence pericardial adipose tissue. No consistent sociodemographic patterns were identified for paracardial and perivascular fat depots.

Recommendations

For patients from socioeconomically or ethnically vulnerable populations and populations with visceral obesity without classic symptoms it would be recommended to perform imaging-based measurements of depots of adipose tissue, especially epicardial adipose tissue and abdominal visceral adipose tissue – this might improve early risk detection in clinical practice. Future research should prioritize standardized, longitudinal studies that integrate fat depot quantification with sociodemographic variables and cardiovascular outcomes to enhance risk stratification and guide targeted prevention.

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