Research Article ISSN 2639-8486

Cardiology & Vascular Research

Assessing the Cardiovascular Alterations from Obesity and Systemic Inflammatory Diseases

Carlos Alberto Paterno Marchioli*

Fellow of the European Society of Cardiology, Cardiovascular Research Laboratory, Castiglion Fiorentino (Tuscany), Italy.

***Correspondence:**
Carlos Alberto Paterno Marchioli, Fellow of the European Society of Cardiology, Cardiovascular Research Laboratory, Castiglion Fiorentino (Tuscany), Italy.

Received: 01 Oct 2025; **Accepted:** 05 Novt 2025; **Published:** 16 Nov 2025

Citation: Carlos Alberto Paterno Marchioli. Assessing the Cardiovascular Alterations from Obesity and Systemic Inflammatory Diseases. Cardiol Vasc Res. 2025; 9(4): 1-5.

ABSTRACT

Traditional and emerging risk factors cause functional and structural damage in the arterial endothelium, leading the patient to various stages and degrees of cardiovascular disability that become incompatible with life.

Diseases with high and low levels of inflammation that act on the arterial wall can develop changes in cardiovascular hemodynamics such as arterial hypertension and even cause the appearance of brief phases of atrial fibrillation.

In this study were entered 1231 patients to observe the responses in cardiovascular hemodynamics assessed with arterial tonometry during the action of low-grade inflammation diseases how obesity and high-grade inflammation from systemic diseases.

A high prevalence of hyperlipidemia was found among systemic inflammatory diseases. Obesity was a major stimulus to receive therapy for arterial hypertension in relation to systemic inflammatory diseases. Both obesity and systemic inflammatory diseases produced the same pathological responses in cardiovascular hemodynamics, and also the presence of brief phases of atrial fibrillation was similar.

Keywords

Obesity, Systemic inflammatory diseases, Arterial hypertension, Central Haemodynamic Parameters, Atrial fibrillation.

Abbreviations

AF: Atrial Fibrillation, AIx: Augmentation Index, Diff AIx: Difference of Aix, CHP: Central Haemodynamic Parameters, SID: Systemic Inflammatory diseases.

Introduction

Obesity is a complex multi-factorial process with the accumulation of lipids into adipocytes located within subcutaneous adipose tissue and/or visceral adipose tissue. Cardiovascular diseases are responsible for two-thirds of excess mortality related to obesity, which has become an epidemic problem in Western society and is one of the leading causes of preventable death [1]. More than a fifth of adults in European countries are obese, a prevalence that has more than doubled in the last 40 years [2].

Obesity presents with a greater total blood volume and greater peripheral tissue resistance, mainly due to the excessive accumulation of adipose tissue and the consequent increase in oxygen demand. In the obesity, visceral adipose tissue is more susceptible to inflammatory and vasoactive cytokines and adipokines, leading to increased macrophage infiltration and chronic low-grade systemic fibro-inflammation to contribute to further exacerbating cardiac remodeling and dysfunction, and an excess risk of atherosclerosis [3,4].

In patients with a BMI >30 kg/m^2 the visceral adipose tissue is associated with the activation of Renin Angiotensin Aldosterone System and the sympathetic nervous system, and produces numerous pro-oxidative and pro-inflammatory substances [5,6].

Additionally, excess adiposity dysregulates the production of adipokines (adiponectin, leptin and resistin) and pro-inflammatory mediators (tumour necrosis factor-α, IL-6, angiotensinogen, and aldosterone) that produce injury in the vasculature [7]. Moreover,

plasma norepinephrine levels are increased due to stimulation of the sympathetic nervous system compared to lean individuals [8].

The resulting neurohormonal activation is an essential contributor to the elevation of systemic blood pressure. The Framingham study proposed that left atrial enlargement was a risk factor in obesity for the development of atrial fibrillation [9].

This topic was analyzed again by Milton Packer, showing how obesity and the systemic inflammation associated with it promote the thickening of epicardial adipose tissue, as well as the secretion of pro-inflammatory cytokines, which can precipitate cardiac remodeling and atrial fibrillation, defining it as a biomarker of an underlying atrial myopathy [10,11]. The traditional risk factors mentioned so far lead to atherosclerosis, which is a low-grade chronic inflammatory state, different from the high-grade chronic inflammatory state associated with autoimmune diseases, such as rheumatoid arthritis and psoriasis, which can lead to accelerated atherosclerosis and are associated with increased cardiovascular risk [12,13]. Recently, a large population-based study conducted by Conrad N, et al. confirmed evidence of an association between autoimmune inflammatory diseases such as Psoriasis, Arthritis Rheumatoid, among others, and cardiovascular risk [14]. Therefore, inflammation of the arterial wall is an important factor in developing its stiffness.

The AIx is an important value to measure this decrease in elasticity through the phenomenon of pulse wave amplification that comes from the periphery, thus increasing central aortic pressure and therefore the systolic overload of the ventricle and left atrium.

In relation to the aforementioned data, this study was developed to compare the alterations produced in cardiovascular hemodynamics, both from obesity and from SID, considering that both present different degrees of inflammatory activity.

Objective

This study was designed primarily to compare the modifications of the Systolic and Diastolic Blood Pressure, CHP, and AIx by the action of the inflammatory conditions of obesity and systemic diseases. In addition, the presence of brief phases of AF was recorded in both illnesses.

Design & Methods

For the purpose of this retrospective cross-sectional epidemiological study, 1,231 patients, both sexes, were enrolled and divided into three groups:

SID Group (without obesity) n=229,

Obesity Group (without SID) n=809, and

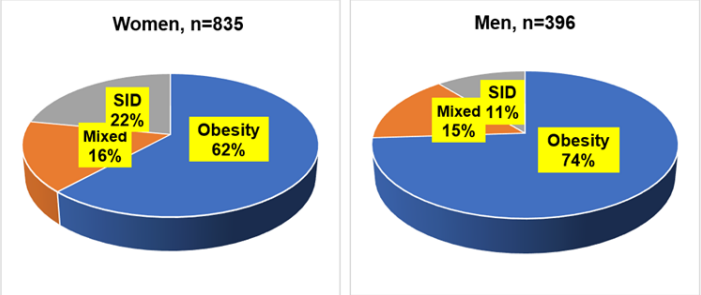
Mixed Group (patients with both conditions: Obesity and SID) n=193 as shown in Figure 1.

Definitions of terms for this study

Obesity

Clinically, obesity is defined as a condition characterized by a Body Mass Index equal to or greater than 30 kg/m2 (body weight divided by height in meters) [15]. Waist circumference/height relationship was measured in order to avoid the error presented by the Body Mass Index measurement alone. The waist circumference/height ratio above the value of 0.59 determines the presence of abdominal obesity in both sexes.

Figure 1: Percentages of the groups Obesity, SID and Mixed, both sexes.



SID: Systemic Inflammatory Diseases.

SID

In this group was entered patients with Rheumatoid Arthritis, Psoriasis, Polycystic Ovary Syndrome, Endometriosis, Sjögren's disease, Crohn's disease, Ulcerative Colitis, Hashimoto's Thyroiditis, Celiac disease, Cholangitis, Interstitial Cystitis, and Bronchial Asthma [16].

Arterial hypertension

The systolic and diastolic blood pressure limit of 120/70 mmHg, indicated as “elevated blood pressure” according to the latest Guidelines on arterial hypertension, was used [17]. The cutoff level of the guidelines agrees with an article by the author in which it is observed that up to the age of 65 years and a systolic/diastolic blood pressure level of 121/73 mmHg, patients practically did not develop phases of atrial fibrillation [18]. Blood pressure measurements were performed according to standard methods using ERKA sphygmomanometers (N° 7102869 – 18031068).

Non-invasive arterial tonometry

Non-invasive arterial tonometry was the method used to record central haemodynamic parameters using the SphygmoCor system PVX model (AtCor-Medical, Australia).

Central Aortic Pressure, End-Systolic Pressure, Mean Arterial Pressure, Pulse Pressure, and Augmentation Pressure were measured and expressed in mmHg. In addition, the AIx was measured and expressed as percentage, with a fidelity operator index >85%.

Differences of the AIx according the sex and age were calculated between the observed values in relation to the maximum normal levels, to assess the statistically differences between groups.

Brief episodes of atrial fibrillation

For this study, it was arbitrarily established that a minimum of 5 consecutive beats of AF to determine electrical instability as indicative of early atrial pathological remodeling.

Holter monitors (SpaceLab Healthcare Ltd, USA. Evo Nº 001877 – 014012) were used to record episodes of brief phases of AF.
Box 2020 ESC – 2022 ESH - 2025 ESH.

Statistical Analysis

Continuous variables were summarized using descriptive statistics. Data were evaluated as mean and standard deviation. Categorical variables were summarized using patient counts and percentages. The differences between the means of the central hemodynamic parameters in male and female patients were compared using the Student's t-test for independent samples. Statistical tests were two-tailed, and the alpha level was set at 0.05. Statistical analysis was performed using SAS version 9.2.

Results

A highest values of the Body Mass Index, Waist Circumference and Waist Circumference/Height ratio has been observed in the Obesity and Mixed groups, both sexes. Normal values were found in the SID group.

In all groups, both sexes, increased systolic and diastolic blood pressure, central haemodynamic parameters, and Diff AIx were registered.
Box 2017 ESH - 2018 ESH - 2024 ESH.

In the group of women, when systolic and diastolic pressure, as well as central hemodynamic parameters, were statistically analyzed, the Obesity group and the Mixed group showed significantly higher values than SID group.
Analyzing the men's group, only diastolic blood pressure showed a significant difference in the Mixed group compared to the other two groups.

A level of hypercholesterolemia (Total Cholesterol ≥200 mg/dL) was observed in the obesity group, both sexes, of 11%, while in the SID and Mixed group it was 37% and 44%, respectively. Analyzing the Diff AIx, it was observed that high data than normal levels were observed in all three groups, both sexes. When Diff AIx values were analyzed among the Obesity, SID and Mixed groups, in the latter two showed a higher value than the Obesity group among women, with a statistically significant difference, while between Mixed and SID group was not. Among men the Diff Aix only the value of the SID group was superior to the Obesity group with a statistically significant difference.

Table 2: Systolic and Diastolic Blood Pressure and CHP. Statistically analysis among groups.

Women	Mixed vs Obesity	Mixed vs SID	Obesity vs SID
Systolic Blood Pressure	0.09	<0.0001	<0.0001
Diastolic Blood Pressure	0.001	<0.0001	0.009
Central Aortic Pressure	0.2	<0.0001	<0.0001
End-Systolic Blood Pressure	0.2	<0.0001	<0.0001
Mean Arterial Pressure	0.009	<0.0001	0.0004
Pulse Pressure	0.4	0.005	<0.0001
Men	**Mixed vs Obesity**	**Mixed vs SID**	**SID vs Obesity**
Systolic Blood Pressure	0.2	0.5	0.7
Diastolic Blood Pressure	0.006	0.007	0.4
Central Aortic Pressure	0.2	0.6	0.8
End-Systolic Blood Pressure	0.2	0.3	0.9
Mean Arterial Pressure	0.4	0.05	0.8
Pulse Pressure	0.9	0.2	0.4

SID: Systemic Inflammatory Diseases. CHP: Central Haemodynamic Parameters.

Table 3: Difference of AIx - Statistically analysis among groups and both sexes.

Diff AIx	Mixed - Obesity	p	Mixed - SID	p	SID - Obesity	p
Women	5.2 – 2.6	0.0016	5.2 – 4.8	0.7	4.8 – 2.6	0.0004
Men	4.3 – 2.7	0.2	4.3 – 5.1	0.6	5.1 – 2.7	0.04

SID: Systemic Inflammatory Diseases. Diff AIx: Difference of Augmentation Index.

Interestingly, similar percentages of brief phases of Atrial Fibrillation were found in all groups and in both sexes; when they were compared, no statistically significant differences were found.

Table 4: Atrial Fibrillation - statistically analysis by both sexes among three groups (n-% - p value).

Atrial Fibrillation	Women – n (%)	Men – n (%)	p value
Total	76 (9.1)	33 (8.3)	0.6
Obesity	48 (9.3)	23 (7.9)	0.5
SID	16 (8.7)	4 (9.1)	0.4
Mixed	12 (9.0)	6 (10.2)	0.7

SID: Systemic Inflammatory Diseases.

Table 1: Obesity, SID and Mixed groups, both sexes: Age, Anthropometric data, SBP, DBP, CHP.

Women	n (%)	Age	BMI	WC	WC / H	SBP	DBP	CAP	ESP	MAP	PP
Obesity	516 (62)	62.5	35.3	107.1	0.69	136.2	81.8	127.5	117.2	102.0	44.6
SID	185 (22)	45.2	24.7	85.0	0.53	129.1	79.6	119.6	110.7	98.0	38.7
Mixed	134 (16)	51.0	36.2	107.9	0.69	139.6	85.1	129.9	119.4	105.4	43.4
Men	**n (%)**	**Age**	**BMI**	**WC**	**WC / H**	**SBP**	**DBP**	**CAP**	**ESP**	**MAP**	**PP**
Obesity	293 (74)	58.1	33.8	113.1	0.67	132.4	83.1	121.7	112.9	100.3	37.5
SID	44 (11)	51.9	25.4	94.6	0.55	133.6	81.6	122.7	113.1	99.8	39.9
Mixed	59 (15)	52.6	35.0	115.5	0.67	136.4	87.4	124.5	116.2	104.6	35.9

SID: Systemic Inflammatory Diseases; BMI: Body Mass Index; WC: Waist Circumference; WC/H: WC/Height; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; CHP: Central Haemodynamic Parameters; CAP: Central Aortic Pressure; ESP: End-Systolic Pressure; MAP: Mean Arterial Pressure; PP: Pulse Pressure.

Table 5: Atrial Fibrillation, statistically differences among groups (p value).

Atrial Fibrillation	Women	Men
Mixed vs Obesity	0.9	0.7
Mixed vs S I D	0.9	0.8
S I D vs Obesity	0.9	0.8

ID: Systemic Inflammatory Diseases

Discussion

Obesity, low-grade inflammation disease, through the production of cytokines by adipocytes, can damage the endothelium of the arterial wall, which in turn can lead to arteriosclerosis and tend to vasoconstriction, contributing to the development of systemic arterial hypertension and can increase haemodynamic parameters. Similar findings were observed during systemic inflammatory diseases assessed. Also, in both groups, brief phases of atrial fibrillation were observed as an early element of atrial electrical instability.

In the group of SID the women had a low age for the presence of the youngest with Polycystic Ovarian Syndrome in the sample. Also, among men with SID the age was low, together the group Mixed, both sexes, perhaps this illness could begin at a young age, exert a strong action over the cardiovascular system in a short time, or both. Obviously, BMI, Waist Circumference, and Waist Circumference/Height ratio were high in the Obesity and Mixed groups. In the SID group, the aforementioned values were normal, then the cardiovascular alterations can be attributed to its inflammatory condition alone. An increase in BMI is associated with a higher risk of developing Heart Failure preserved Ejection Fraction [19].

Despite optimal control of traditional risk factors, cardiovascular events, even fatal ones, persist in some patients, a risk attributed in part to autoimmune inflammatory diseases. The links between the immune system and atherogenesis are well established [13,14,17,20].

Chronic SID are associated with premature atherosclerosis and high blood pressure. It was observed that the SID and Mixed groups, a very high percentage of hypercholesterolemia was found in relation to the Obesity group, which would contribute to the oxidation of lipoproteins, subsequently leading to endothelial dysfunction, arterial stiffness, atherosclerosis and arterial hypertension.

Hypertension was treated at a very high rate in the Obesity group (83%) compared to the SID (10%) and Mixed (22%) groups. It is possible that the physicians treating obese patients associated with hypertension considered the presence of cardiovascular risk. In the Mixed group, the percentages of patients treated for hypertension were higher than in the SID group, indicating that the presence of Obesity predisposes to a greater tendency to treat hypertension.

It is evident how obesity accelerates cardiovascular deterioration (aging) and together with SID are an important cause for the appearance of AF, directly affecting the structure and function of the cardiovascular system. Clearly, the damage is observed in the arteries where part of the systemic inflammation process impacts, which can be measured through non-invasive methods such as arterial tonometry and quantified with the Diff AIx. With this method it was observed that the highest values belong to the SID and Mixed groups in relation to the Obesity group, therefore it could be correlated that a greater degree of inflammation of the disease corresponds to greater arterial damage. Although the inflammatory states of Obesity and SID are of varying degrees, the damage produced in the arterial wall is on the same level, which would allow these diseases to be included as belonging to a common inflammatory system.

The so-called Arterial Hypertension is a cardiovascular complication of an initial endocrine-metabolic-environmental process that, by producing arterial stiffness and increasing the volume/pressure of the arterial-ventricular-atrial system, can eventually produce the appearance of atrial fibrillation.

This work included recording the brief phases of AF as an element that demonstrates an important cardiovascular complication, and to find out if different degrees of systemic inflammation could correlate with different responses of atrial electrical remodeling. Therefore, the finding of observing brief phases of AF in patients would be indicative of a hypertensive disease already developed when some patients do not yet present blood pressure figures higher than the data currently accepted as "normal".
Box 2023 ESH

Box
Posters presented by the author:
2017 ESH - Comparison of the detrimental effect of psoriasis and rheumatoid arthritis measured on central haemodynamic parameters in prevalent overweight-obesity and hypertensive population
2018 ESH - Assessment of the central haemodynamic parameters during oestrogen- progesterone therapy in women with polycystic ovarian syndrome
2020 ESC - Angiotensin receptor blockers and mineralocorticoid receptor antagonists therapy reach better central haemodynamic parameters and avoid the episodes of atrial fibrillation
2022 ESH - What is the significance and the meaning from finding a wandering atrial rhythm?
2023 ESH - Early diagnosis of hypertensive disease in youth with normal systolic and diastolic blood pressure levels
2024 ESH - Systemic diseases are a group of inflammatory illnesses that can damage the arterial wall assessed according to non-invasive arterial tonometry
2025 ESH - Minimal mitral regurgitation and electrical abnormalities of the atrium could develop from arterial stiffness, assessed by non-invasive arterial tonometry

Conclusions

A high prevalence of hyperlipidemia was found among systemic inflammatory diseases. Obesity was a major stimulus to receive therapy for arterial hypertension in relation to systemic inflammatory diseases.

In patients with obesity and/or systemic inflammatory diseases, high blood pressure, increased central haemodynamic parameters, arterial stiffness, and brief phases of atrial fibrillation were found, although both illnesses had different degrees of inflammatory activity. Obesity, a low-grade inflammation disease, is already sufficient to produce several alterations in the cardiovascular system.

References

1. Lavie CJ, Milani RV. Obesity and cardiovascular disease: the Hippocrates paradox?. J Am Coll Cardiol. 2003; 42: 677-679.
2. Koskinas KC, Van Craenenbroeck EM, Antoniades C, et al. ESC Scientific Document Group. Obesity and cardiovascular disease: an ESC clinical consensus statement. Eur Heart J. 2024; 45: 4063-4098.
3. Ruperez C, Madeo F, de Cabo R, et al. Obesity accelerates cardiovascular aging. Eur Heart J. 2025; 46: 2161-2185.
4. Lechner K, McKenzie AL, Kränkel N, et al. High-risk atherosclerosis and metabolic phenotype: the role of ectopic adiposity, atherogenic dyslipidemia, and inflammation. Metab Syndr Relat Disord. 2020; 18: 176-185.
5. Rana MN, Neeland J. Adipose tissue inflammation and cardiovascular disease: an up-date. Curr Diab Rep. 2022; 22: 27-37.
6. Hall JE, do Carmo JM, da Silva AA, et al. Obesity, kidney dysfunction and hypertension: mechanistic link. Nat Rev Nephrol. 2019; 15: 367-385.
7. Ridker PM, Tuttle KR, Perkovic V, et al. Inflammation drives residual risk in chronic kidney disease: a CANTOS substudy. Eur Heart J. 2022; 43: 4832-4844.
8. Young JB, Macdonald IA. Sympathoadrenal activity in human obesity: heterogeneity of findings since 1980. Int J Obes Relat Metab Disord. 1992; 16: 959-967.
9. Wang TJ, Parise H, Levy D, et al. Obesity and the risk of new-onset atrial fibrillation. JAMA. 2004; 292: 2471-2477.
10. Stritzke J, Markus MRP, Duderstadt S, et al. The aging process of the heart: obesity is the main risk factor for left atrial enlargement during aging the MINCA/KORA (monitoring of trends and determinations in cardiovascular disease/ cooperative research in the region of Augsburg) study. J Am Coll Cardiol. 2009; 54: 1982-1989.
11. Packer M. Epicardial adipose tissue may mediate deleterious effects of obesity and inflammation on the myocardium. J Am Coll Cardiol. 2018; 71: 2360-2372.
12. Elnabawi YA, Dey AK, Goyal A, et al. Coronary artery plaque characteristics and treatment with biologic therapy in severe psoriasis: results from a prospective observational study. Cardiovasc Res. 2019; 115: 721-728.
13. Piepoli MF, Hoes AW, Agewall S, et al. ESC Scientific Document Group. Authors/Task Force Members. 2016 European Guidelines on cardiovascular disease prevention in clinical practice: The Sixth Joint Task Force of the European Society of Cardiology and others Societies on Cardiovascular Disease Prevention in Clinical Practice (constituted by representatives of 10 societies and by invited experts). Developed with the special contribution of the European Association for Cardiovascular Prevention & Rehabilitation (EACPR). Eur Heart J. 2016; 37: 2315-2381.
14. Conrad N, Verbeke G, Molenberghs G, et al. Autoimmune diseases and cardiovascular risk: a population-based study on 19 autoimmune diseases and 12 cardiovascular diseases in 22 million individuals in the UK. Lancet. 2022; 400: 733-743.
15. Black D, James WPT, Besser GM et al. (Membership of the Working Party). Obesity. A report of the Royal College of Physicians. J R Coll Physicians Lond. 1983; 17: 5-65.
16. Paterno Marchioli CA, Ingaramo RA. El asma bronquial podría pertenecer al grupo de las enfermedades sistémicas inflamatorias (Bronchial asthma could belong to the group of inflammatory systemic diseases). Rev Fed Arg Card. 2025;54(4):in press
17. McEvoy JW, McCarthy CP, Bruno RM, et al. ESC Scientific Document Group. 2024 ESC Guidelines for the management of elevated blood pressure and hypertension. Developed by the task force on the management of elevated blood pressure and hypertension of the European Society of Cardiology (ESC) and endorsed by the European Society of Endocrinology (ESE) and the European Stroke Organisation (ESO). Eur Heart J. 2024; 45: 3912-4018.
18. Paterno Marchioli CA. Atrial fibrillation, when and what are the optimal blood pressure values to prevent it?. Cardiol Vasc Res. 2024;8(2):1-7.
19. Pandey A, LaMonte M, Klein L, et al. Relationship between Physical Activity, Body Mass Index, and Risk of Heart Failure. J Am Coll Cardiol. 2017; 69: 1129-1142.
20. Ogdie A, Yu YD, Haynes K, et al. Risk of major cardiovascular events in patients with psoriatic arthritis, psoriasis and rheumatoid arthritis: a population-based cohort study. Ann Rheum Dis. 2015; 74: 326-332.