

Association of Obesity with Renal Damage by Ultrasound in Patients Aged 30 to 59 Years from UMF 7 of Orizaba, Veracruz

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ABSTRACT

Background: Obesity is defined as a chronic, multifactorial disease in which an increase in body fat causes adipose tissue dysfunction, leading to metabolic alterations. In Mexico, it presents a significant health problem and leads to multiple complications. A high BMI is associated with the development of proteinuria in people without kidney disease, as well as a low estimated glomerular filtration rate. Ultrasound (US) plays a fundamental role in the evaluation of morphological changes in the renal structure.

Objective: To demonstrate the association between obesity and kidney damage in patients aged 30 to 59 years at Family Medicine Unit No. 7 in Orizaba, Veracruz.

Materials and Methods: A longitudinal, analytical, and prospective study was conducted at Family Medicine Unit No. 7 in Orizaba, Veracruz, from November 2022 to May 2023, including all obese patients aged 30 to 59 years. Patients with a BMI > 30 were selected and classified into obesity grades. Glomerular filtration rate was calculated using serum creatinine levels and the CKD-EPI 2021. Renal ultrasound was performed to evaluate morphology. Frequency measures and percentages were used for qualitative variables, and measures of central tendency and dispersion were used for quantitative variables. The association was calculated using the chi-square test. The level of statistical significance was set at $p \leq 0.05$.

Results: Kidney damage was observed in 61 patients (20.3%) who were obese. Females predominated, with 163 (54.2%) patients, and the mean age was 42 years, with a median of 41 years, reflecting that the study population consisted of young adults.

Conclusions: This study does not show a correlation between obesity and ultrasound-detected kidney damage in patients aged 30 to 59 years at Family Medicine Unit No. 7 in Orizaba, Veracruz.

KEYWORDS: Obesity, Chronic kidney disease, Glomerular filtration rate, Renal ultrasonography.

ARTICLE DETAILS

Published On:
11 February 2026

Available on:
<https://ijmscr.org/>

THEORETICAL FRAMEWORK.

Obesity is defined as a chronic, multifactorial, and neurobehavioral disease, in which an increase in body fat causes dysfunction of adipose tissue and an alteration in the physical forces of body fat, resulting in adverse metabolic, biomechanical, and psychosocial alterations to health. (1)

Obesity and overweight have reached epidemic proportions. Obesity rates have almost tripled since 1975, affecting people of all ages and social groups in the Region of the Americas and the world. The Region of the Americas has the highest prevalence of all World Health Organization regions. Obesity

is estimated to affect 28% of the adult population (26% of men and 31% of women). (2)

Mexico is one of the countries concerned with understanding the health and nutritional status of its population. For this reason, the National Institute of Statistics and Geography (INEGI) presents indicators such as the 2018 National Health and Nutrition Survey (ENSANUT), which was conducted during 2018. The age group reporting the highest prevalence of obesity is the 30-59 age group: 35% of men and 46% of women suffer from it. In the 20-29 age group, the prevalence of obesity is 26%, increasing to 46% in the 30-59 age group. (3)

Association of Obesity with Renal Damage by Ultrasound in Patients Aged 30 to 59 Years from UMF 7 of Orizaba, Veracruz

The state of Veracruz is experiencing an alarming situation. Obesity, overweight, and diabetes must be considered the main health problems to be addressed in the state, as it ranks among the highest in the nation for this indicator. According to the 2012 National Health and Nutrition Survey (ENSANUT), it is estimated that **31.2% of adults** in Veracruz are obese. The distribution by sex showed a higher prevalence for men (41.7%) compared to women (39.8%). (4) Obesity has a multifactorial origin, resulting from an energy imbalance characterized by the intake of high-calorie foods rich in fat and a decrease in physical activity and/or sedentary behavior. Genetic, environmental, and social factors also contribute, including chronic stress. This combination leads to a state of chronic inflammation with hyperplasia and hypertrophy of adipocytes, resulting in excessive lipid accumulation in adipose tissue and abnormal adipokine secretion. (5-7)

In adults, the most widely used parameter for measuring overweight and obesity is the body mass index (BMI), which is easy to determine and allows for the identification of overweight and obesity at both the individual and population levels. BMI is defined as weight in kilograms divided by the square of height in meters (kg/m^2). BMI is the same for both sexes and all ages (in adults). (8,9)

A high BMI is associated with the development of proteinuria in people without kidney disease, as well as a low estimated glomerular filtration rate (eGFR). There are adiposity-induced effects on the endocrine activity of adipose tissue through the production of adiponectin, leptin, and resistin that could affect the kidneys. The World Health Organization (WHO) considers a BMI between 18.5 and 25 kg/m^2 to be normal weight, a BMI between 25 and 30 kg/m^2 to be overweight, and a BMI of 30 kg/m^2 to be obese. (10,11)

Obesity can be considered a risk factor for the development of kidney disease, since there is a likelihood of a compensatory hyperfiltration mechanism occurring to meet the metabolic demands of increased body weight. (12)

The most well-known way in which obesity can affect the kidneys is obesity-related glomerulopathy (ORG), characterized by glomerulonephritis, which may or may not be accompanied by focal segmental glomerulosclerosis (FSGS). Within the latter, perihilar lesions predominate and are observed in hypertrophied glomeruli. Focal mesangial sclerosis and thickening of the glomerular and tubular basement membranes are frequently observed in obese patients without diabetes. (13,14)

Similarly, obesity is associated with reduced preglomerular vascular resistance and increased glomerular flow; these hemodynamic changes result in glomerular hypertension, glomerulomegaly, and microvascular stretching that eventually leads to podocyte loss and the development of FSGS lesions. (15)

Obesity-associated glomerulopathy is a proteinuric kidney disease in patients with a body mass index (BMI) $> 30 \text{ kg}/\text{m}^2$

and without clinical and histopathological evidence of other kidney diseases. Histopathologically, glomerulomegaly and focal segmental glomerulosclerosis (FSGS) are characteristic findings, reflecting intraglomerular hyperfiltration. (16)

Obesity-related glomerulopathy and other adaptive nephropathies are known as hyperfiltration nephropathies, the most common cause of renal dysfunction in obesity and diabetes mellitus, as these conditions are associated with increased renal plasma flow, filtration fraction, and glomerular filtration rate. When renal plasma flow increases to a lesser extent than the glomerular filtration rate, it implies the presence of renal vasodilation affecting the glomerular afferent arteriole. In renal hyperfiltration, there is an increase in the volume of the glomerular tuft, Bowman's space, tubular epithelium, and tubular lumen. (17,18)

In hyperfiltration, the physical forces affecting the glomerulus are the blood flowing in the glomerular capillaries and the ultrafiltrate flowing from the capillaries into Bowman's space, causing mechanical stress on the capillary wall. Albuminuria can increase in the early stages of kidney damage in diabetes and obesity, reaching the so-called microalbuminuric range: 30 to 300 mg/day. Therefore, inhibition of proximal tubular reabsorption reduces hyperfiltration glomerulopathy in obese, non-diabetic subjects. (19)

Other mechanisms involved in obesity-associated glomerulopathy include chronic inflammation, oxidative stress, insulin resistance, apoptosis, etc. Renal lipid deposition has also been linked to the development of obesity-associated glomerulopathy, as it manifests as lipid deposits in the glomeruli and tubules of patients with a body mass index of 30 kg/m^2 . It has been reported that patients with obesity-associated glomerulopathy develop progressive renal failure and may even progress to end-stage renal disease. (20,21)

Chronic kidney disease is defined as a decline in kidney function demonstrated by a glomerular filtration rate (GFR) of less than 60 ml/min per 1.73 m^2 , or by markers of kidney damage, or both, of at least three months' duration, regardless of the underlying cause. (22)

Ultrasound (US) plays a fundamental role in the evaluation of both morphological changes in renal structure (using B-mode) and renal and extrarenal vascularization patterns (using color Doppler and contrast-enhanced US), thus contributing to the diagnosis of early kidney damage, acute or chronic nephropathies, and nephrovascular disease in hypertensive patients. (23,24)

Ultrasonography is a non-invasive and low-cost diagnostic modality that provides sufficient anatomical detail to diagnose kidney diseases without exposing the patient to radiation or contrast agents. All these factors favor the early detection and prediction of abnormalities in renal function tests. The maximum renal diameter is a morphological marker of CKD. It decreases concurrently with the

Association of Obesity with Renal Damage by Ultrasound in Patients Aged 30 to 59 Years from UMF 7 of Orizaba, Veracruz

Glomerular Filtration Rate (GFR) and shows a significant correlation with both renal and cortical diameter. Cortical thickness has been shown to correlate with renal function. Kidney volume measured by ultrasound correlates well with the stage and progression of CKD and can be used to assess CKD progression. (25-27)

Muftah Othman and colleagues at the Sheffield Kidney Institute, UK, examined the medical records of 125 non-diabetic patients with chronic kidney disease (CKD) and followed them for 10 years, retrospectively collecting sociodemographic, clinical, and biochemical data. Participants were classified into normal weight, overweight, and obese groups. An estimated glomerular filtration rate (eGFR) was obtained annually to assess the role of obesity (BMI) in CKD progression. The results showed that the rate of CKD progression, based on the annual decline in eGFR (1.1 ml/min/1.73), was 62.5% for overweight patients and 79.5% for obese patients, compared to 44.7% for normal-weight CKD patients. (28)

Ping Yang et al. conducted a controlled study with mice at the Lipid Research Center and Key Laboratory of Molecular Biology for Infectious Diseases and other institutions in China. The mice were fed a high-fat diet and injected with casein, and kidney damage was assessed using histology. They concluded that inflammatory stress promotes the deposition of ectopic lipids in the kidney and causes kidney injury in obese mice. (29)

Shotaro Hoi and colleagues at the Division of Medicine and Clinical Sciences, Faculty of Medicine, Tottori University, Yonago, Japan, conducted a study in 2018 to investigate the predictive value of kidney morphology assessment by ultrasound for the progression of chronic kidney disease. They performed ultrasound on 87 patients with chronic kidney disease, measuring kidney length, volume, cortical thickness, and medullary thickness. They measured renal function at baseline and two years later, correlating the morphological values. They concluded that cortical thickness correlated with a decline in renal function, with a sensitivity of 72.5% and a specificity of 80% for the risk of a greater than 30% decrease in renal function. (30)

Justification.

Obesity is now considered a chronic disease and a potent risk factor for the development of kidney disease. Obesity-related glomerulopathy is the hallmark of kidney dysfunction associated with this condition. Mexico ranks second in obesity prevalence, and Veracruz ranks fifth nationally, making this condition a priority health problem for our state. Detecting renal morphological changes in obese patients could be highly useful for identifying earlier stages of chronic kidney disease (CKD). CKD places a significant burden on the healthcare system, causing premature death from the disease itself and, to a lesser extent, a decline in quality of life due to the resulting disability.

Renal ultrasound and glomerular filtration rate measurement are low-cost diagnostic methods that provide sufficient information about renal morphology and function to diagnose kidney disease in its early stages. Therefore, they could be implemented as part of the management of patients with obesity.

Therefore, it is necessary that the care of people with obesity become an essential part of the comprehensive approach at the primary care level, implementing measures aimed at preventing complications and modifying dietary habits to promote a healthy lifestyle. This involves seeking interventions to reduce the risk of complications, starting in primary care for obese individuals.

Problem statement.

Obesity is a chronic, complex, and multifactorial metabolic disease with epidemic dimensions worldwide. This global obesity epidemic has immense socioeconomic and medical consequences. The kidneys can also be affected by the detrimental effects of obesity. It has been estimated that in 14–30% of patients with chronic kidney disease (CKD), overweight/obesity likely plays a significant pathogenic role. Viewing obesity as a clinical condition associated with other comorbidities rather than as the cause itself often leads to it being underdiagnosed and undertreated.

Obesity is the leading cause of non-communicable diseases that drive up healthcare costs, leading to increased multimorbidity and a decline in quality of life. Therefore, it is essential that the care of people with obesity be an integral part of the comprehensive approach physicians provide to their patients.

The good news is that obesity, as well as related CKD, is largely preventable. Education and awareness about the risks of obesity and a healthy lifestyle, including proper nutrition and exercise, can greatly help prevent both obesity and kidney disease. Which leads us to the next research question:

What is the association of obesity with kidney damage as determined by ultrasound in patients aged 30-59 years from UMF 7 in Orizaba, Veracruz?

General objective.

To demonstrate the association of obesity with kidney damage using ultrasound in patients aged 30 to 59 years from UMF 7 in Orizaba, Veracruz.

Specific objectives:

Identify patients with obesity using BMI, aged 30-59 years, who attended the outpatient clinic of UMF 7 in Orizaba, Veracruz.

Estimating the glomerular filtration rate using the CKD-EPI 2021 formula in obese patients aged 30-59 years, who attended the outpatient clinic of UMF 7 in Orizaba, Veracruz. To assess renal morphology using ultrasonography in obese patients aged 30-59 years, who attended the outpatient clinic of UMF 7 in Orizaba, Veracruz.

Hypothesis.

Association of Obesity with Renal Damage by Ultrasound in Patients Aged 30 to 59 Years from UMF 7 of Orizaba, Veracruz

- Alternative hypothesis

There is an association of obesity with kidney damage through ultrasound in patients aged 30-59 years from UMF 7 of Orizaba, Veracruz.

- Null hypothesis

There is no association of obesity with kidney damage as determined by ultrasound in patients aged 30-59 years from UMF 7 in Orizaba, Veracruz.

MATERIALS AND METHODS

Study design: a longitudinal, analytical, and prospective study was conducted.

Study location: Family Medicine Unit No. 7, Orizaba Veracruz.

Development period: from November 2022 to May 2023.

Work universe: all those patients aged 30 to 59 years , assigned to UMF 7, Orizaba Veracruz.

Population: all patients with obesity aged 30 to 59 years , assigned to UMF 7, Orizaba Veracruz.

Selection criteria.

- Inclusion criteria: Male and female patients with obesity, aged 30 to 59 years, assigned to UMF 7, Orizaba Veracruz
- Exclusion criteria:
All those patients outside the age range of 30-59 years.
All patients aged 30 to 59 years without obesity.
Those patients with chronic degenerative disease that causes some kidney damage.
- Elimination criteria:
Those patients who did not have serum creatinine.
Those patients who did not undergo renal ultrasound.
Those patients who did not wish to participate in the study.

Definition of variables.

VARIABLE NAME	CONCEPTUAL DEFINITION	OPERATIONAL DEFINITION	TYPE OF VARIABLE/MEASURING SCALE	INDICATOR OR INDEX
Age	Time a person has lived since birth.	Age at the time of study.	Qualitative. Discreet.	30-39 years 40-49 years 50-59 years
Gender	Group to which human beings of each sex belong, understood from a sociocultural point of view rather than exclusively biological.	Phenotype that the individual presents at the time of the study.	Quantitative. Nominal.	1. Man 2. Woman
Obesity	A chronic, multifactorial, and neurobehavioral disease, where an increase in body fat causes adipose tissue dysfunction and adverse metabolic, biomechanical, and psychosocial alterations to health.	According to the WHO: Grade I obesity 30.0–34.9. Grade II obesity 35.0–39.9. Grade III obesity > 40.	Qualitative. Ordinal.	1.- Grade I obesity 2.- Grade II obesity 3. Grade III obesity
Glomerular filtration rate	It is the volume of fluid filtered from the renal glomerular capillaries into Bowman's capsule per unit of time.	According to KDIGO 1.- Stage 1: Kidney damage (e.g., protein in urine) with normal GFR; >90 ml/min/1.73m2.	Qualitative.	1.- Stadium 1

		2.- Stage 2: Kidney damage with slight decrease in GFR; 60 to 89 ml/min/1.73m². 3.- Stage 3: Moderate decrease in GFR; a) 45 to 59 ml/min/1.73m² and b) 30 to 44 ml/min/1.73m². 4.- Stage 4: Severe reduction of GFR; 15 to 29 thousand/min/1.73m². 5.- Stage 5: Renal insufficiency; less than 15 ml/min/1.73m².	Ordinal.	2.- Stadium 2 3.- Stadium 3 4.- Stadium 4 5.- Stadium 5
Renal ultrasound characteristics	A renal ultrasound, also called a "renal sonogram," is a safe and painless examination that uses sound waves to create images of the kidneys. It is used to assess kidney morphology. Morphological parameters of normal kidneys: Longitudinal diameter Right kidney 10.9+-12-13 cm Left kidney 11.2+-12-13 cm Interpersonal variability (mm) 12-20 Anteroposterior thickness 50-60 mm Cortical thickness >10 mm Corticomedullary thickness 16-18mm Kidney geometric volume (V=0.49xAxBxC) (cm³) Right kidney 134	Morphological characteristics that determine kidney damage: 1.- Longitudinal diameter. Right kidney <10.9 cm Left kidney <11.2 cm 2.- Renal asymmetry in longitudinal diameter >2 cm 3.- Anteroposterior thickness <50-60 mm 4.- Cortical thickness <7 mm 5.- Corticomedullary thickness <13 mm 6.- Geometric volume of the kidney Right kidney <134 cm³ Left kidney <146 cm³ 7.- Renal sinus volume	Qualitative. Nominal.	1.- Kidney damage by ultrasound (minimum meeting three criteria). 2.- No kidney damage by ultrasound (if only one criterion is met)

Left kidney 146	Right kidney < 24 cm ³
Renal sinus volume (V=0.49xAxBxC) (cm ³) 21 (left); 24 (right)	Left kidney < 21 cm ³
Parenchyma echogenicity	8. Increased echogenicity of the parenchyma

Overview of the study.

Prior submission and authorization from the Local Committee for Research and Ethics in Research and Health, (CLIIS) based at the Orizaba Regional General Hospital, No. 1, as well as written authorization to the director of the Family Medicine Unit No. 7 of Orizaba, Veracruz, for the performance of said study with authorization No. R-2022-3101-077.

A longitudinal, analytical study was conducted, identifying patients aged 30 to 59 years attending the outpatient clinic of Family Medicine Unit No. 7 in Orizaba, Veracruz. These patients were weighed and measured to obtain their Body Mass Index (BMI) by dividing their weight in kilograms by the square of their height in meters. Patients with a BMI greater than 30 were selected and classified according to the WHO classification of kidney damage. It was then determined whether they had a recent serum creatinine value (no more than three months old); if not, this test was requested using the appropriate form. Once the results were obtained, the glomerular filtration rate (GFR) was calculated using the CKD-EPI 2021 formula, and the patients were classified according to the degree of kidney damage.

Stadiums

FG 90 – 120 ml: normal value.

GFR < 60 ml/min: Chronic Kidney Disease (CKD).

Stage 1: Kidney damage (e.g., protein in urine) with normal GFR; >90 ml/min/1.73m².

Stage 2: Kidney damage with slight decrease in GFR; 60 to 89 ml/min/1.73m².

Stage 3: Moderate decrease in GFR; 30 to 59 ml/min/1.73m².

Stage 4: Severe reduction of GFR; 15 to 29 thousand/min/1.73m².

Sample size calculation.

FORMULA

Population: 1598

$$n = \frac{3.84 \times 0.50}{0.0025} \times 0.50 \times \frac{1598}{(1598 - 1) + 3.84 \times 0.50 \times 0.50}$$

$$n = \frac{1534.08}{3.9925 + 0.96}$$

Stage 5: Renal failure; less than 15 ml/min/1.73m².

They were subsequently given an order for a renal ultrasound and were given an appointment by phone to come and have it done.

During the appointment, the patient was taken to the ultrasound room where they were placed in the supine position. Using a low-frequency convex probe (3.5–5.5 MHz), a scan was performed following the kidney protocol. Longitudinal (superior-inferior) and transverse (anteroposterior) scans were performed to fully visualize the kidney (both poles and hilum). A subcostal approach was used (asking the patient to take a deep breath to displace the kidneys downwards and facilitate visualization), as well as an intercostal approach using the liver and spleen as acoustic windows. The following aspects were assessed:

- Kidney status
- Kidney size
- Ecostructure
- Cortical regularity
- Cortical echogenicity
- Corticomedullary delimitation
- Images added overlay.

Once the results of the TFG and renal ultrasound were obtained, the joint evaluation of renal morphology and function was carried out, and the results obtained were then communicated to each participant by telephone.

Sample

A formula for finite populations was used, as the unit has a census of patients with obesity. Therefore, the number of patients with this condition in the age group specified for this study was determined, and is detailed below:

n = 1534.08
4.9525

n = 309.75

Statistical analysis.

The data obtained were captured and analyzed using the SPSS statistical software. Frequency measures and percentages were used for qualitative variables, and measures of central tendency and dispersion were used for quantitative variables. The association was calculated using the chi-square test. The level of statistical significance was ≤ 0.05 .

Ethical aspects.

This study complies with the requirements of the International Ethical Guidelines for Biomedical Research and Experimentation Involving Human Subjects, ISBN 92 9036 05 6 9. Council for International Organizations of Medical Sciences (CIOMS), 1993, Geneva, pp. 53-56, the Regulations of the General Health Law of the United Mexican States regarding experimentation in human beings, and the Instructions of the Research Commission of the Mexican Social Security Institute. Reference is also made to the Official Mexican Standard NOM-012-SSA3-2012, which establishes the criteria for the execution of research projects in human beings.

The methods to be used in this research adhere to the ethical standards of the Regulations of the General Health Law on Research and the Declaration of Helsinki of 1965. It is considered a risk-free research that will have the informed and written consent of the research subject.

The information obtained will be kept confidential in a coded and encrypted database on a computer within the hospital premises, where it will be completely under the supervision of the associated researchers and will be used strictly for research and scientific dissemination purposes.

RESULTS.

In accordance with the objective of this project, a longitudinal and analytical study was carried out on 301 people with a BMI greater than 30 in an age range of 30 to 59 years of age, attached to UMF 7, Orizaba Veracruz, where it was found that in 61 patients (20.3%) they presented ultrasound renal damage.

It was found that, of the total sample of 301 participants with a BMI greater than 30, 163 (54.2%) were women and 138 (45.8%) were men. (see figure 1)

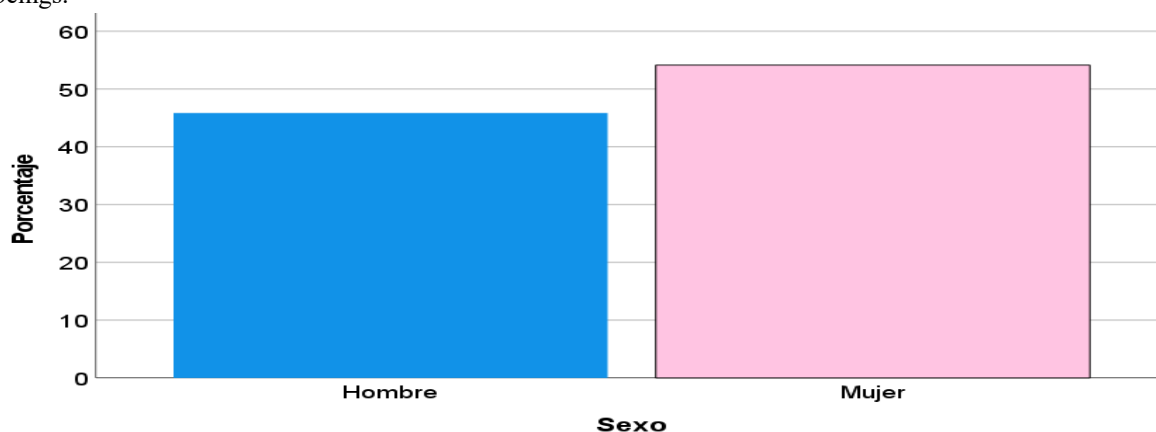


Figure 1. Sex of patients with obesity.

A predominance of females (54.2%) was observed. n=301

It was also observed that in the age range chosen for this study, according to measures of central tendency, it showed a mode of 31 years, a mean of 42 years, and a median of 41 years of age, as shown in Figure 2.

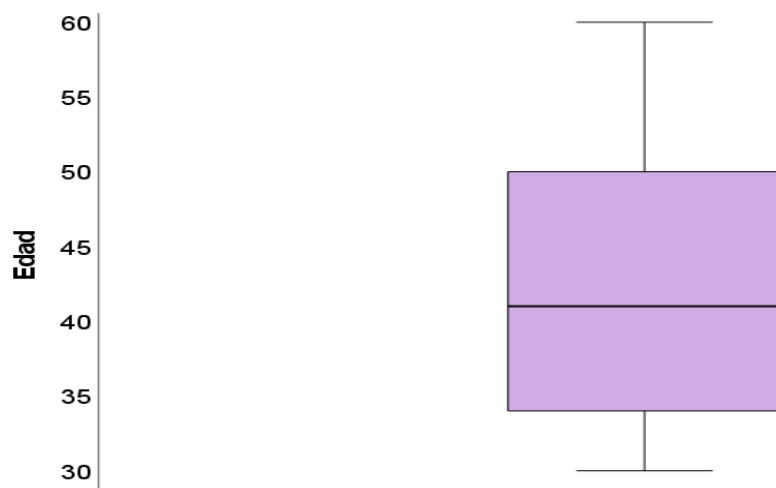


Figure 2. Age range of participants.

The median age is 41 years, with an approximate range between 35 and 50 years. n=301

The degree of obesity was determined according to BMI (body mass index) and classified according to the WHO as

follows: grade I obesity with 218 (72.4%), grade II obesity with 70 (23.3%), and grade III obesity with 13 (4.3%). (see figure 3)

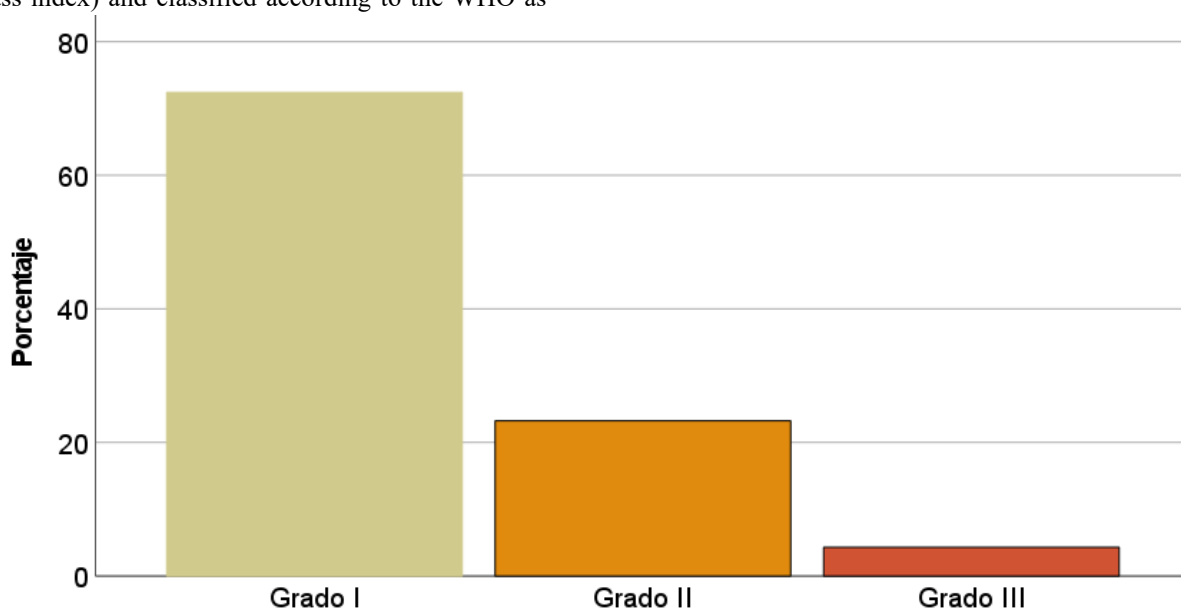


Figure 3. Degree of obesity according to the WHO BMI classification.

Distribution of participants according to the degree of obesity based on BMI. Grade I obesity predominated with 218 (72.4%). n=301

The GFR was also considered to correlate the ultrasound changes with the stage of kidney damage, finding stage 1 to all those with a GFR > 90 ml/min/1.73m² (including those with an increased GFR and/or ultrafiltration) with 235 (78.1%), stage 2 with 58 (19.3%), stage 3 with 4 (1.3%) being the main stage since it defines chronic kidney disease biochemically, stage 4 with 4 (1.3%) , and stage 5 with 0 (0%), n=301 (see figure 4).

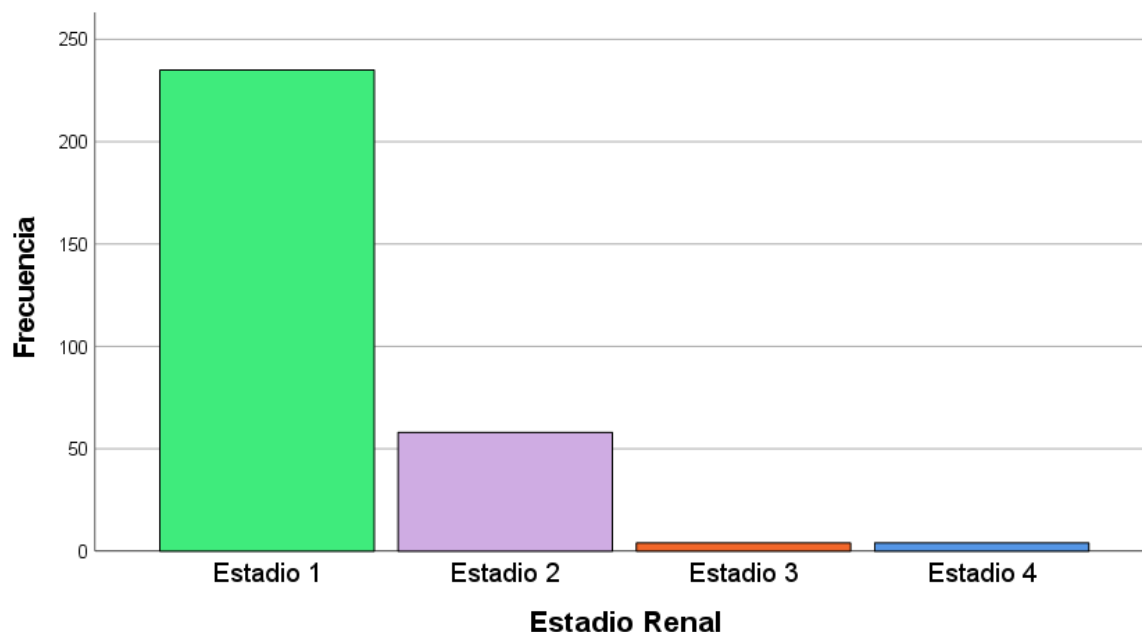


Figure 4. Renal Stage according to TFG.

Distribution of participants according to renal stage based on GFR. The majority were found in stage 1 of 235 (78.1%) $n=301$.

The following table shows the main ultrasound findings related to kidney damage in patients with the assessed obesity grades (GI, GII, and GIII). It can be seen that abnormal values were more frequent in the grade I and II obesity groups, with a tendency to decrease in the grade III obesity group due to

the smaller number of cases. The parameters evaluated included renal longitudinal diameter, interrenal asymmetry, anteroposterior thickness, cortical and corticomedullary thickness, as well as geometric and renal sinus volumes.

The most common findings were decreased longitudinal renal diameter (<10.9 cm in right kidney and <11.2 cm in left kidney) and reduced anteroposterior thickness (<50 – 60 mm), especially in the group with grade I obesity (See table).

Table 1. Ultrasound characteristics of kidney damage according to the degree of obesity.

	GI Obesity	Grade Obesity	II Obesity	GIII
1. Longitudinal diameter.				
Right kidney <10.9 cm	103	30	2	
Left kidney <11.2 cm	133	43	3	
2.- Renal asymmetry in longitudinal diameter >2 cm				
	5	0	0	
3.- Anteroposterior thickness <50–60 mm				
	192	51	5	
4.- Cortical thickness <7 mm				
	77	18	5	
5.- Corticomedullary thickness <13 mm				
	64	16	5	
6.- Geometric volume of the kidney				
Right kidney <134 cm ³	93	15	1	
Left kidney <146 cm ³	95	20	2	
7.- Renal sinus volume				
Right kidney <24 cm ³	153	51	10	
Left kidney <21 cm ³	127	39	9	
8.- Increased echogenicity of the parenchyma				
	38	9	3	

Ultrasound findings related to kidney damage, more frequent in the groups with grade I obesity, $n=301$.

The finding was hyperfiltration above 125 ml/min/ 1.73 m² in 12 (5%) of those classified in Stage 1, 235 (78.1%).

The following table presents data on the relationship between the degree of obesity and the presence or absence of

Association of Obesity with Renal Damage by Ultrasound in Patients Aged 30 to 59 Years from UMF 7 of Orizaba, Veracruz

ultrasound-detected kidney damage, as well as the corresponding totals and percentages.

Most of the individuals in the study are in Grade 1 obesity, both with kidney damage (49) and without kidney damage (169).

The percentage of kidney damage is highest in Grade 1 (80.3%) and decreases in the higher grades of obesity.

The study showed a χ^2 value of 3.101, $p=0.212$.

Table 2. Correlation between obesity and renal ultrasonography.

Obesity	With kidney damage		No kidney damage		Total	χ^2	p
	F	%	F	%			
Grade 1	49	80.3	169	70.4	218	3.101	0.212
Grade 2	9	14.8	61	25.4	70		
Grade 3	3	4.9	10	4.2	13		
Total	61		240		301		

No correlation was observed between the degree of obesity and renal ultrasound damage, $p = 0.212$, $n=301$.

The following table shows the distribution of patients according to the presence or absence of kidney damage as determined by ultrasound evaluation, in relation to the glomerular filtration rate (GFR) stages. A higher proportion

of cases with kidney damage is observed in the initial stages (1 and 2), while no cases corresponding to stage 5 were recorded. The Chi-square formula ($\chi^2 = 7.028$; $p = 0.071$) indicates that there is no statistically significant association between GFR stage and the presence of ultrasound-detected kidney damage.

Table 3. Relationship between ultrasound assessment of kidney damage and glomerular filtration rate stage in obese patients.

Ultrasound evaluation					
Stadium (TFG)	With kidney damage	No kidney damage	Total	χ^2	p
1	48	210	258	7.028	0.071
2	13	24	37		
3	0	5	5		
4	0	1	1		
5	0	0	0		
	61	240	301		

No damage was observed by ultrasound and the GFR, $p=0.071$, $n=301$.

DISCUSSION

An association between obesity and kidney damage was found using ultrasound in patients aged 30 to 59 years at Family Medicine Unit 7 in Orizaba, Veracruz. Of these, only 61 (20.3%) showed obesity, and 8 (2.6%) showed a decrease in glomerular filtration rate. This aligns with a study by Elisabeth Ejerblad et al. in 2006 in Sweden, who analyzed anthropometric data from a national population-based case-control study of incident cases of moderate chronic kidney disease (CKD). The study included cases in a European population aged 18 to 74 years with CKD whose serum creatinine exceeded 3.4 mg/dL (men) or 2.8 mg/dL (women) for the first time and permanently during the study period. A total of 926 cases and 998 controls were randomly selected from the study database. Self-administered questionnaires

provided information on anthropometric measurements and other lifestyle-related factors. Logistic regression models, adjusted for several cofactors, estimated the relative risk of chronic kidney disease (CKD) in relation to body mass index (BMI). Overweight (BMI > 25 kg/m²) at age 20 was associated with a three-fold increased risk of CKD compared with a BMI < 25. Obesity (BMI > 30) in men and morbid obesity (BMI > 35) in women, at any point in life, were associated with a three- to four-fold increased risk. Analyses limited to strata without hypertension or diabetes revealed a three-fold increased risk among patients who were overweight at age 20, while the twofold increased risk observed among those with a peak lifetime BMI > 35 was not statistically significant. Obesity appears to be an important, and potentially preventable, risk factor for CKD. (34)

Association of Obesity with Renal Damage by Ultrasound in Patients Aged 30 to 59 Years from UMF 7 of Orizaba, Veracruz

In contrast to the results obtained by Sara-Joan Pinto - Sietsma et al., who in 2003 studied the relationship between body weight and fat distribution, microalbuminuria, and elevated or decreased filtration in 7,676 subjects without diabetes, aged 28 to 75 years, at the Department of Internal Medicine, Division of Nephrology, University Hospital of Groningen. They divided the subjects into groups according to body weight (overweight > 25 and ≤ 30 kg/m²; obesity, BMI > 30 kg/m²) and fat distribution. They concluded that Not only overweight and obese individuals, but also lean individuals with central fat distribution are at risk of reduced filtration. Therefore, this appears to be important for kidney failure. (32)

Despite the results obtained with a low percentage of ultrasound abnormalities in obese patients for the development of kidney damage, the literature mentions in previous studies the deterioration of kidney function, such as Rebecca P. Gelber, M, et al, in 2006 in Boston where they evaluated the association between body mass index (BMI) and the risk of chronic kidney disease (CKD) in a cohort of 11,104 initially healthy male patients who participated in the Physicians' Health Study and provided a blood sample after 14 years. Glomerular filtration rate (GFR) was estimated, and CKD was defined as a GFR less than 60 mL/min/1.73 m² (<1 mL/s/1.73 m²). After a mean follow-up of 14 years, 1,377 participants (12.4%) had a GFR less than 60 mL/min/1.73 m² (<1 mL/s/1.73 m²). A higher baseline BMI was consistently associated with an increased risk of CKD. Similar associations were observed when using different BMI categories. Those who reported a BMI increase greater than 10% had a significantly increased risk of CKD (OR, 1.27; 95% CI, 1.06 to 1.53). In this large cohort of initially healthy men, BMI was significantly associated with an increased risk of CKD after 14 years. (35)

However, Meredith C. Foster et al. at Boston University Medical Center conducted an analysis in 2008 using participants from the Framingham Offspring Study (n = 2676; 52% female; mean age, 43 years) who were free of stage 3 chronic kidney disease at baseline in 2008. The Framingham Offspring Study cohort was established in 1971 and includes 5124 men and women who were children and spouses of children in the original Framingham cohort. Examinations of participants in the Offspring Study cohort were performed approximately every four years. Offspring Study cohort members who attended the second (1978–1982) and seventh (1998–2001) examination cycles were included in this analysis. The study resulted in a final sample of 2676 individuals. The mean follow-up was 18.5 years (range: 15.9 to 21.9 years). Overall, 7.9% of participants (n=212) developed stage 3 CKD. At baseline, 51.8% of participants (n=1387) were of normal weight, 36.0% (n=964) were overweight, and 12.1% (n=325) were obese. Mean eGFR at baseline was slightly higher in normal-weight and obese individuals than in overweight individuals. (33)

This study aimed to analyze the association of obesity with kidney damage using ultrasound, obtaining insignificant data despite findings reported in the literature. However, Shakeel Ahmed (2019) at the ultrasound department of Dr. Ziauddin Hospital, Clifton campus, Karachi, Pakistan, studied the role of ultrasound in the diagnosis of chronic kidney disease (CKD) and its correlation with serum creatinine levels. This was a retrospective cross-sectional study conducted in 2017 over a six-month period. A total of 200 patients with CKD and a glomerular filtration rate (GFR) < 60 mL/min were included. Blood samples were collected from the selected patients, serum creatinine was estimated, and they underwent ultrasound on the same day to assess echogenicity, parenchymal thickness, cortical thickness, and longitudinal length. The mean age of the patients was 54.62 ± 13.3 years. They concluded that the best sonographic parameter that correlates with serum creatinine is renal cortical echogenicity and its grading compared to longitudinal length, parenchymal thickness, and cortical thickness in patients with CKD. Since renal cortical echogenicity has the advantage of being irreversible compared to serum creatinine levels, it can be used as a parameter of renal function (26).

Just like Mustafa Yaprak in 2016 in Turkey with 120 patients with CKD in stages 1–5 investigated the association between e-GFR and the CKD ultrasound score calculated through ultrasound parameters.

Data on the relationship between estimated glomerular filtration rate (e-GFR) and three renal ultrasound (US) parameters, including kidney length, parenchymal thickness, and parenchymal echogenicity, are limited in chronic kidney disease (CKD). Glomerular filtration rate was estimated, and US was performed by the same radiologist, who was blinded to the patients' medical history and laboratory results. US parameters, including kidney length, parenchymal thickness, and parenchymal echogenicity, were obtained from both kidneys. All three parameters were scored. for each kidney, separately. The sum of the average scores for these parameters was used to calculate the CKD ultrasound score. The mean age of the patients was 63.34 ± 14.19 years. The mean kidney length, parenchymal thickness, CKD ultrasound score, and median parenchymal echogenicity were found to be 96.2 ± 12.3 , 10.97 ± 2.59 mm, 6.28 ± 2.52 , and 1.0 (0–3.5), respectively. The eGFR was positively correlated with kidney length ($r = 0.343$, $p < 0.001$) and parenchymal thickness ($r = 0.37$, $p < 0.001$), and negatively correlated with CKD score ($r = -0.587$, $p < 0.001$) and parenchymal echogenicity ($r = -0.683$, $p < 0.001$). Receiver operating characteristic (ROC) curve analysis for distinguishing eGFR less than 60 mL/min showed that an ultrasonographic CKD score greater than 4.75 was the best parameter, with a sensitivity of 81% and a positive predictive value of 92% (AUC, 0.829; 95% CI, 0.74–0.92; $p < 0.001$). A correlation was found between eGFR and the CKD ultrasound score using all ultrasound parameters. Furthermore, our study showed that the CKD ultrasound

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score can be useful in distinguishing stage 3–5 CKD from stages 1 and 2. We suggest that the CKD ultrasound score provides more objective data in the assessment of CKD. (27) Muftah Othman et al. (2008), Sheffield Kidney Institute, North General Hospital, University of Sheffield, Sheffield, UK, conducted a retrospective cohort study to assess whether obesity influences the rate of progression of non-diabetic chronic kidney disease (CKD). The medical records of 125 patients with non-diabetic CKD from Sheffield Kidney were reviewed. Patients were studied at the Institute, Sheffield, UK, and followed for 10 years. Various sociodemographic, clinical, and biochemical parameters were retrospectively collected from the patient database. Participants were categorized into normal weight, overweight, and obese groups. Multivariate regression analysis was used for modeling, with estimated glomerular filtration rate (eGFR) as the dependent variable, to assess the impact of obesity (BMI) on CKD progression. Results: The patients studied were primarily in stage 3 CKD, with a mean eGFR of 36.2 ml/min/1.73 m² for the control group and 44.3 ml/min/1.73 m² for those who were overweight or obese. The mean triglyceride level during follow-up was significantly higher in obese patients than in those of normal weight ($p = 0.042$). The rate of CKD progression based on the annual decline in eGFR (≥ 11 ml/min/1.73 m²/year) was 62.5% in overweight and 79.5% in obese patients compared with 44.7% in normal-weight CKD patients ($p = 0.007$). Baseline BMI was an independent predictor of CKD progression (eGFR decline, ml/min/1.73 m²/year) ($R^2 = 0.122$ and $p < 0.001$). Conclusions: Baseline BMI and younger age are strongly and independently associated with more rapid CKD progression, as measured by the annual rate of eGFR decline. (28)

It is important to note that the highest prevalence of sonographic kidney damage was found in patients with grade I obesity. This finding could be related to the analyzed sample, in which this obesity group predominated. However, some studies indicate that the risk of progression to kidney disease increases with more advanced grades of obesity, highlighting the need for research with larger samples and homogeneous distributions to establish stronger associations.

CONCLUSIONS

The results of the present study do not confirm the alternative hypothesis that proposed a direct association between obesity and kidney damage detectable by ultrasound in patients aged 30 to 59 years from UMF No. 7 of Orizaba, Veracruz, since no statistical significance was obtained in the relationship evaluated.

However, a clinically relevant finding was identified: a high percentage of patients with obesity presented glomerular hyperfiltration, which can be considered as a compensatory mechanism and an early marker of renal alterations associated with excess body weight.

This result emphasizes the importance of the timely detection of functional and structural renal changes in obese patients, even in the absence of evident ultrasound damage, with the aim of implementing preventive strategies that reduce the risk of progression to chronic kidney disease.

Despite these limitations, the results obtained are relevant in the context of primary care, as they underscore the usefulness of renal ultrasound as an accessible tool for monitoring subclinical kidney damage in obese patients. This reinforces the need for preventive interventions focused on weight loss, metabolic control, and regular renal monitoring, especially in patients with cumulative risk factors.

Overall, a significant proportion of patients were found to have kidneys with reduced dimensions and cortical thicknesses, suggesting structural changes consistent with incipient kidney damage. The most common findings were decreased renal longitudinal diameter (<10.9 cm in the right kidney and <11.2 cm in the left kidney) and reduced anteroposterior thickness (<50 – 60 mm), especially in the group with grade I obesity.

The results of this study do not align with those reported in the literature regarding the association with morphological renal damage detectable by ultrasound. However, 15 (5%) patients showed glomerular hyperfiltration as a compensatory mechanism. This reinforces the hypothesis that obesity represents a significant risk factor for the development of kidney disease, but that its sonographic manifestations may appear late in the clinical course.

In conclusion, this study highlights the urgent need for preventive and weight management strategies in the adult population, as well as the integration of renal assessment methods into routine clinical practice to prevent progression to chronic kidney disease. Furthermore, it would be worthwhile to follow these patients in another study to assess the progression of kidney damage if they do not address their obesity.

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