

A CROSS SECTIONAL STUDY OF CHOLELITHIASIS ON ULTRASOUND: ASSOCIATION WITH DEMOGRAPHIC AND RISK FACTORS

Tehreem Zahra¹, Aneeq Ul Rehman², Noor Fatima³, Palwasha Khan⁴, Maria Ayub⁵, Mehnil Zahra⁶, Dr. Rao Kabir Aman⁷

¹Lecturer, University of Management and Technology, Lahore, Pakistan

²Gull International Hospital, Tarnol, Islamabad, Pakistan

³MS Diagnostic Ultrasound, The University of Faisalabad, Pakistan

⁴BS Medical Imaging Technology, Liaquat University of Medical & Health Sciences (LUMHS), Jamshoro, Pakistan

⁵Medical Diagnostic Sonographer, Dr. Essa Laboratory and Diagnostic Center, Lahore, Pakistan

⁶BS Medical Imaging Technology, University of Management and Technology, Lahore, Pakistan

⁷CEO, Aesthetics by Kabir Clinic, Lahore, Pakistan

¹tehreemzahra608@gmail.com, ²aneeq4167@gmail.com, ³noorfatimashahid07@gmail.com,

⁴pathanwaheed678@gmail.com, ⁵mariaayub591@gmail.com, ⁶mehnil1214@gmail.com,

⁷raomubammadaman@gmail.com

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Corresponding Author: *

Tehreem Zahra

Abstract

Objective: To evaluate the prevalence of cholelithiasis as detected by ultrasound and to assess its association with various demographic variables (Age, gender) and risk factors (diabetes, high cholesterol, hypertension, BMI).

Aim of study: Ultrasound as reliable diagnostic tool, a focused evaluation of diagnostic patterns of cholelithiasis in relation to the factors such as age, gender, BMI, co morbid conditions like diabetes, hypertension are essential for detection and prevention strategies in Pakistan.

Methodology: A cross-sectional observational study was conducted in the Radiology Department of Social Security hospital lahore over a period of 15th April 2025 to 20th August 2025 to evaluate the prevalence of cholelithiasis as detected by ultrasound and its association with demographic and risk factors. The study population was included adult patients aged 18 years and above, of both sexes, who are referred for abdominal ultrasound during the study period and who provide informed consent. Patients with a history of cholecystectomy, pregnant women, and those with incomplete clinical data was excluded from the study. A standardized data collection form was used to record risk factors, such as history of diabetes mellitus, hypertension, high cholesterol, and body mass index (BMI), as well as demographic information, such as age and gender. Measurements of height and weight was recorded and used to calculate BMI. The collected data was analyzed using statistical software such as SPSS. Descriptive statistics was used to summarize the characteristics of the study population. The prevalence of cholelithiasis was expressed as a percentage. Associations between cholelithiasis and categorical variables was assessed using the Chi-square test. A p-value of less than 0.05 will be considered statistically significant.

Result: Among the 109 participants assessed by ultrasound for cholelithiasis, the highest prevalence was observed in the 40–60 years age group (53.2%),

followed by 18–40 years (28.4%) and 60–80 years (18.3%), with no significant correlation between age and number of gallstones ($p = 0.684$). Females constituted the majority (80.7%), while males accounted for 19.3%; however, the number of gallstones was not significantly associated with gender ($p = 0.248$). A positive family history of gallstones was reported in 56.0% of participants, yet no significant correlation was found with the number of gallstones ($p = 0.079$). Regarding BMI, 57.8% had abnormal BMI, which showed a statistically significant association with multiple gallstones on ultrasound ($p = 0.039$). High cholesterol was present in 58.7% of cases, but this did not correlate significantly with gallstone number ($p = 0.310$). Similarly, no significant associations were found between number of gallstones and diabetes (25.7% diabetic; $p = 0.295$) or hypertension (61.5% hypertensive; $p = 0.517$).

Conclusion: Among the evaluated demographic and risk factors, only BMI showed a statistically significant association with the severity and multiplicity of gallstones on ultrasound. Obesity was found to be a key contributing factor, indicating that it not only increases the risk of developing cholelithiasis but also its severity.

INTRODUCTION

Cholelithiasis is the worldwide most common disease, it is the condition in which stones are develop in gallbladder composed of bile, bilirubin and cholesterol. Gallbladder is situated in the upper right hypochondriac region in which bile is stored and produced by the liver. Most of the time, this is asymptomatic but patients may also come with right hypochondriac pain (MAHDI and JAAFAR 2024). The most common prevalent biliary disease is gallstones. 8% to 20% of patients with the age of 40 to 60 has been observed with cholelithiasis(Nasir, Zulfiqar et al. 2021).

Gallstones can be single or multiple in gallbladder. The composition of single stones are mostly cholesterol stones while mixed stones composed of low cholesterol content. Solitary stones are white in color, smooth, yellow because they are cholesterol in nature while mixed stones may be layered, grey white to black in color depending on the composition(Sharma, Walia et al. 2023). Gallstones are characterized into 3 types according to the composition 1) Pure cholesterol stones which are made up of about 90% cholesterol. Second type is pigment stones, which contain 90% bilirubin, brown or black in color. 3rd type is mixed composition stones which contain cholesterol, bilirubin, calcium carbonate, calcium phosphate, calcium palmitate More than 70% of gallstones in

Pakistani population are composed of cholesterol primarily(Njeze 2013).

Cholesterol stones are green, white, yellow in color which are made of cholesterol. Pigmented stones are black or brown in color contain less than 20% cholesterol and are composed of bilirubin and calcium salts. Mixed stones are the mixture of cholesterol and pigmented stones (Figure1) (Thamer and Sciences 2022)

Imbalance between the liver-gallbladder-intestine system in which cholesterol synthesis processes are carried out can also cause development of gallstones disease (Parra-Landazury, Cordova-Gallardo et al. 2021). Gallbladder is the pear-shaped organ just lie inferior to the liver, which is about 1 inch wide and 3 to 4 inches long. The main function of Gallbladder is to store bile, bile is released from gallbladder into small intestine during digestion. Bile helps out in the digestion of fat, which is a bitter, greenish mixture of acid, salts and other substance (Bhatti, Waqar et al. 2016). In the gallbladder, abnormal high level of cholesterol or bilirubin in bile can cause cholelithiasis (Song, Ma et al. 2022).

The inferior surface of gallbladder is covered by the peritoneum and its superior surface has no capsule but in contact with the liver. Liver capsule is known as Glisson's capsule. Gallbladder has a wide fundus which continues to the main body of gallbladder and having narrow diameter. Superior to the fundus, there

is a fold called Phrygian cap, which having no importance of pathology. Infundibulum is the continuation of the main body of GB, which connects with the neck and cystic duct. which makes connection with neck and cystic duct. Inferior part of infundibulum or neck is called Hartmann's pouch. (Figure2) (Jones, Hannoodee et al. 2022).

The gallbladder is 7-10 cm long, 3-4 cm wide. The capacity of gallbladder is roughly 50ml and the wall thickness of gallbladder is 2mm which changes with the gallbladder distension(Mehmood, Uzair et al. 2021).

Three mechanisms are of major importance in the formation of cholesterol gallbladder stones: (1) cholesterol supersaturation of bile< (2) gallbladder hypomotility, and (3) kinetic, pro-nucleating protein factors (Figure3) (Marschall and Einarsson 2007).

The basic mechanism is that liver secretes cholesterol in bile, and the excess proportion is carried by lecithin cholesterol vesicles, in which cholesterol level is high and can easily aggregates. When aggregated, this allows the initiation of most aggregation of stones. Then granulocytes triggered when cholesterol crystals are formed, which expel the DNA out of the cell which will encapsulate the cholesterol crystals. Individual crystal start aggregates to form the large stones. Therefore, super saturation of cholesterol is necessary prerequisite for gallstones(Rafiq, Khan et al. 2024)

Ultrasound is the best imaging tool to identifying the gallstones due to broad availability and dynamic acquisition. The first line imaging modality for gallbladder diseases is ultrasound. The appropriate scanning technique is required for the assessment of gallstones. Scanning technique includes 6 to 8 hours of fasting to ensure the gallbladder is adequately distended, high frequency transducer(Fung, Spsychka et al. 2025).

Ultrasound in radiology for the diagnosis of gallbladder wall thickness, lumen changes, especially posterior acoustic shadows of gallstones (>1.5 mm diameter in size) is the gold standard technique with the sensitivity and specificity of 95% and 93.1% respectively. The gallbladder is seen below the liver in longitudinal subcoastal scan, it appears as an anechoic area where stones are present(Portincasa, Moschetta

et al. 2006). On ultrasound in gallbladder lumen, cholelithiasis presented as a highly reflective echogenic structure with the posterior acoustic shadowing(Sharif, Vlahaki et al. 2021). Cholelithiasis can also be cause by some conditions such as acute cholecystitis, biliary colic, obstructive jaundice, to eliminate these conditions gallstones require accurate and early diagnosis. The most accurate method to diagnose the stone in gallbladder is Ultrasound imaging. The reason is that this technique is invasive, allows imaging in real time. To evaluate the stone, size of the stone, its position in gallbladder, high frequency sound waves are used to create the detailed images of gallbladder through ultrasound. In early stage of disease, it may be difficult to differentiate the type of gallstones or other pathologies of gallbladder which have the same signs like polyps, tumor, sludge. Because accuracy of ultrasound can be affected by obese patients, position of gallbladder, number of stones, size of the stones(Hong, Zafar et al. 2025).

In the early 1980s, introduction of real-time, diagnostic sonography provided an accurate new method for assessing the prevalence of gallstones with high sensitivity and specificity in detecting the gallstones. Diagnostic sonography is free of adverse effects. In particular, diagnostic ultrasound can also detect asymptomatic gallstones, which can reflect the prevalence of gallstones (Kratzer, Mason et al. 1999).

The cardinal symptoms of gallbladder disease are colicky pain in the upper abdomen, jaundice, and fever. Symptomatic gallstones disease can result for a variety of symptoms. The annual rate of gallstones complication is 1-3% for symptomatic gallstones and only 0.1-0.3% of asymptomatic patients. Gallbladder with multiple stones increases the risk of symptomatic cholelithiasis (Gutt, Schläfer et al. 2020).

The liver function tests and abdominal ultrasound is recommended for the detection of gallstones for those patients showing the signs of gallstones such as abdominal pain, or fever. Majority of patients over 80% have no symptoms during their lifetime and chances of having symptoms decreases over time (Lee, Keane et al. 2015). The prevalence of gallbladder stones varies in different population and regions. The gallstones can range in size from tiny grains to

large stones that can also obstruct bile ducts (Ullah, Habib et al. 2025).

Ultrasound is the primary diagnostic modality for the detection of cholelithiasis besides this, ultrasound has the capability to evaluate the sonographic manifestation of acute cholecystitis like thickened gallbladder wall over distended lumen and the presence of Murphy's sign (Khan, Anwar et al. 2024)

The prevalence of gallstones is high and a common disease worldwide which effects about 10-20% of population in west. 5-8% of eastern Asian population is affected by gallstones. The patients about 20% with gallstones have no biliary symptoms or complications. To treat the gallstones, there are numerous methods and surgical intervention. Cholelithiasis can be a risk factor to develop other complications like gallbladder carcinoma, cholesterol cancer and cardiovascular diseases. Asymptomatic patients are more prone to develop these conditions. By knowing this, that gallstones are the risk factor itself so, it is important to prevent the disease (Siddiqa, Khan et al. 2024).

The prevalence of cholelithiasis varies in different region and population. Prevalence in Pakistan of cholelithiasis is 10.2% while 10% in American adults and 5.9% to 21.9% in Western Europe. Non-Alcoholic fatty liver disease is also an independent risk factor which can result in formation of gallstones. On greyscale ultrasound, gallstones are highly reflective echogenic foci with posterior shadowing in gallbladder lumen. To differentiate the cholelithiasis from polyps on ultrasound, change the patient position movement of stones in gallbladder is observed referred as rolling stone sign. Small stones appear as twinkling artefact on colour doppler (Rehman, Shafi et al. 2021).

Gallstones may increase the risk of gallbladder cancer, pancreatitis, cholecystitis, and biliary tract blockage. Because severe acute biliary inflammation/infection linked to sepsis and multiple organ failure is typically diagnosed and treated late, gallstone-associated disorders frequently need cholecystectomy and endoscopic biliary drainage (Higashizono, Nakatani et al. 2022).

Gallstones (GS) can affect people of any age, but they are more common in the fourth and fifth decades of life and their incidence rises with

each decade of life. Gallstones affect 20–30% of Westerners aged 65 and roughly 10% of non-Westerners in the same age range (Rahman, Iqbal et al. 2022). In United States over 6.3 million men and 14.2 million women are affected by gallstones, among them most patients are asymptomatic and 10% patients showed symptoms within 5 years. The association of gallstones increases with the age and 25% of women above 60 years affected by the gallstones. (Jones, Weir et al. 2024).

Worldwide, cholelithiasis is very common in females and is frequently linked to sex hormones, particularly during the reproductive years. One of the biggest risk factors is being a female. The prevalence of gallstones in women is two to three times greater than in men. Other risk factors include being over 40 and being a woman, mostly because of the effects of the hormone estrogen. High estrogen levels can cause the development of gallstones by increasing bile cholesterol levels and decreasing gallbladder mobility (Shahzad, Waqar et al. 2020).

According to several research, the effects of the hormone estrogen caused women to have a larger proportion than men. A class of female hormones known as estrogen includes the C18 steroids hormone estetrol (E4), estrone (E1), estradiol (E2), and estriol (E3). Steroidogenic cells absorb cholesterol, store it, and transfer it to the location of steroid production. By means of the "E2-ESR1-SREBP-2" pathway, the liver secretes bile cholesterol and E2 promotes the manufacture of cholesterol in the conventional estrogen regulatory system. The primary mechanism by which cholesterol production rises in response to elevated blood estrogen levels is the activation of sterol regulatory element binding protein-2 (SREBP-2) by estrogen. These alterations cause bile to become supersaturated, excessively secrete freshly generated cholesterol, and are readily associated with gallstone formation and cholesterol precipitation (Hendarto, Akbar et al. 2023).

The body mass index (BMI; in Kg / m²) is a broad measure of obesity. The Upper Body Mass Index (BMI) is regarded as an independent risk factor for getting gallstones. Prior, studies have demonstrated a strong link between obesity and cholelithiasis. The typical and traditional risk

factors for Female, forty, overweight, and fertile are all factors that contribute to cholelithiasis. The body mass index (BMI; expressed in kilograms per square meter) is a standard statistic used to measure obesity and gallstones. The development of gallstones is thought to be independently risky for the Higher Body Mass Index (HMI). In previous studies, there is a strong relation of obesity with cholelithiasis, the exact cause is unknown (Shahzad, Waqar et al. 2020).

Many epidemiological studies have found that a higher BMI is associated with a higher risk of gallstone disease; however, the strength of the association has varied among studies; some have found that the risk is two to three times higher among obese people, while other studies that use more precise and extreme BMI classifications have found that the risk is up to five to seven times higher among obese people. It's unclear what the ideal body mass index is to avoid gallbladder illness. By implementing health policies that aim to reduce the prevalence of obesity globally, the incidence of gallstones and consequences connected to gallstones will decline (Paudel, Thapa et al. 2024).

Excess body fat in adipose tissues is a defining feature of obesity, a medical disorder that has detrimental effects on health. Two types of obesity are distinguished: peripheral obesity (pear-shaped) and abdominal or central obesity (apple-shaped). Gallstones can develop as a result of obesity in a number of ways. First of all, it may result in a rise in bile cholesterol secretion, which would cause the gallbladder's bile to become supersaturated. Gallstones are encouraged to form by this supersaturation. Furthermore, because obesity impairs gallbladder motility, it can interfere with the gallbladder's regular emptying, which increases the risk of gallstone formation. Patients who are obese may react more strongly to fat accumulation in the liver, which can also lead to gallstone development (Hendarto, Akbar et al. 2023).

It has been noted that the risk of gallstone disorders is positively correlated with hypertension. Gallstones may be largely caused by high blood pressure. According to earlier observational research, there is a substantial

correlation between GSD and hypertension (Wang, Hu et al. 2022).

Over one billion persons worldwide suffer from hypertension (HTN), a serious public health concern [10]. About 80 million people, or 33% of adults in the US, suffer from HTN, and the projected direct and indirect expenses in 2012 were \$49 billion. About half of these people have uncontrolled blood pressure, especially those who have gallstones, for whom high blood pressure has been linked to an increased risk of gallstones. The composition of bile may change as a result of hypertension, increasing the risk of gallstone formation. The gallbladder may not contract and drain as efficiently if hypertension impairs gallbladder motility (Zhang, Duan et al. 2024).

The etiology of gallstones caused by cholesterol is complex and multifaceted. Crystal nucleation, bile salt and phospholipid concentrations, gallbladder dysmotility, cholesterol hypersecretion and supersaturation, and gallbladder absorption and secretion functions are all known risk factors for cholesterol gallstones (Atamanalp, Keles et al. 2013).

Cholesterol, the most common ingredient in gallstones, is a form of lipid that the liver makes and the biliary system gets rid of. Because gallstone production is so intricate and multifaceted, cholelithiasis is challenging to cure. Cholesterol hypersecretion and supersaturation, phospholipid and bile salt concentrations, crystal nucleation, gallbladder dysmotility, and gallbladder absorption and secretion functions are all factors linked to the development of cholesterol gallstones. Although research has been done to elucidate the connection between gallstones and cholesterol levels, the results are still debatable (Abete, Astrup et al. 2010).

Formation of cholesterol gallstones is positively correlated with elevated cholesterol levels. A recent study that found a favorable link between high cholesterol levels, high cholesterol stone rates, and high stone cholesterol concentrations supports the conclusions of these studies. But according to Thijs, Knipschild, and Brombacher (1990), there is a negative relationship between cholesterol and the risk of gallstones. High levels of low-density lipoprotein (LDL) are a sign of an elevated risk of cholesterol gallstone disease,

according to other thorough research investigating the connection between LDL levels and gallstone formation. However, there is an inverse relationship between LDL levels and gallstone risk, which explains factors associated with serum lipids(Acalovschi 2001).

Gallstone development and low levels of high-density lipoprotein (HDL) have been linked in other studies. For instance, whereas Thijs et al. (1990) and Tang (1996) found an inverse link between low HDL levels and gallstone disease, Andreotti et al. (2008) and Fu et al. (1995) showed an increased risk of gallstone disease in patients with low HDL levels. Furthermore, there was no evidence of a link between gallstone formation and low HDL levels. It is possible that elevated bile cholesterol excretion and cholesterol gallstone disease will result from high cholesterol, high LDL, and low HDL levels. However, the association between blood cholesterol, LDL, HDL, and triglyceride levels and the development of cholesterol gallstones is complex, multivariate, and also reliant on other individual characteristics(Yang, Tang et al. 2022).

Cholelithiasis and biliary tract inflammation have been observed to be commonly linked to diabetes mellitus. However, it is still unclear what causes gallstone complications in people with diabetes mellitus. The term "diabetic neurogenic bladder" refers to the inadequate gallbladder contraction seen in diabetes individuals, particularly those with autonomic neuropathy, when compared to healthy persons(TANNO, Koizumi et al. 1988). Globally, the prevalence of DM is rising. There are two reasons why people with diabetes are more likely to develop gallstones. First, the body produces more total cholesterol, which encourages the development of cholesterol stones. Second, people with diabetes. Additionally, patients frequently have enlarged gallbladders with decreased motility, which increases the development of cholesterol crystals(Hendarto, Akbar et al. 2023).

It is estimated that 11.77 percent of Pakistanis have diabetes mellitus. In addition to gallstones, people with diabetes are more likely to have acalculous gallbladder disease. Because diabetics have severe and ongoing gallbladder infections, cholelithiasis may advance more quickly in these

patients. Gallstone disease in people with diabetes mellitus is reported to be 36.2% prevalent worldwide(Ali, Ahamad et al. 2018). Previous studies have typically focused on individual or limited risk factors for gallstone formation. In contrast our study incorporates a broader range of variables, including demographic factors (age, gender) and clinical risk factors such as hypertension, Obesity, high cholesterol, body mass index (BMI) and diabetes. The objective of this study is to conduct are comparative analysis of these risk factors to determined which one exhibits the strongest association with gallstone development.

RESEARCH METHODOLOGY

STUDY POPULATION:

The study included patients with cholelithiasis symptoms who visit several hospitals in Lahore for an abdominal ultrasonography scan.

STUDY DESIGN:

Cross-sectional observational qualitative study was conducted to investigate the risk factors and demographics of cholelithiasis in those patients undergoing abdominal ultrasound.

CLINICAL SETTING:

The study was conducted in radiology department of Social Security Teaching Hospital Lahore.

DURATION OF STUDY:

The duration of this study was 2 months.

SAMPLE SIZE:

The sample size included 109 patients who were older than 18 and complained of nausea, vomiting, and stomach pain, usually in the right upper quadrant.

SAMPLE TECHNIQUE:

Following formula used to calculate the size of the sample by keeping the reference of the parent article for population.

$$n = \frac{Z^2 * P * (1 - P)}{d^2}$$

N=Sample size

Z=Z-statistic (e.g., 1.96 for 95% confidence)

P=Estimated prevalence(proportion)

d=desired precision (margin of error)

n= 109

SAMPLE SELECTION:

INCLUSION CRITERIA:

- Demographic: (Age 18years and above. gender: Male and Female)
- Patient present with (High cholesterol, diabetes, hypertension, BMI) are include

EXCLUSION CRITERIA:

- Age below 18years
- Pregnant women
- Patients with previous cholecystectomy, CLD and hepatitis
- Patients having other diseases like GB Carcinoma and gallbladder polyps etc.

METHODOLOGY:

After obtaining informed consent, patients were instructed to fast for 6–8 hours before the abdominal ultrasound examination to ensure optimal visualization of the gallbladder. Ultrasound scanning was performed using a

curvilinear transducer with a frequency range of 2.5–7.5 MHz. Patients were examined in different positions, including supine, left lateral decubitus, intercostal, subcostal, and posterior oblique positions, to obtain clear views of the gallbladder and surrounding structures.

Ultrasonic gel was applied to the right upper abdomen, and real-time images were obtained to assess gallbladder stones, wall thickness, pericholecystic fluid, common bile duct size, liver enlargement, gallbladder size, and the presence of stones in the common bile duct. Each examination took approximately 15–20 minutes.

Patient information, including age, weight, height, diabetes status, hypertension, and cholesterol levels, was collected through clinical history. Ultrasound findings were recorded, and the collected data were entered into a structured questionnaire (Performa) for further analysis.

RESULTS

Table 4.1 frequency distribution of age

Age	Frequency	Percent
18-40years	31	28.4
40-60years	58	53.2
60-80years	20	18.3
Total	109	100.0

The data on the association of gallstones show the frequency of age group 18-40Y was 31(28.4%), age group 40-60Y was 58(53.2%), age group 60-80Y was20(18.3%).

Table 4.2 Cross table of age

		18-40Y	40-60Y	60-80Y	Total	P-Value
No of gallstones on USG	Single	13	21	6	40	0.684
	Multiple	18	37	14	69	
Total		31	58	20	109	

Table 4.2 and figure 4.1 show that there is no significant correlation between no. of gallstones and age with p-value of 0.684 ($p > 0.05$).

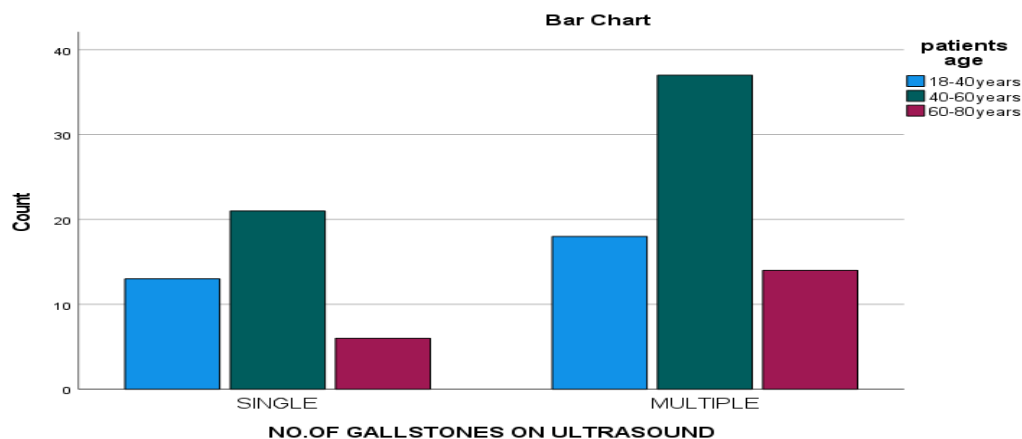


Figure 4.1 Bar chart of of patient age

Patient Gender

Table 4.3 Frequency distribution of patient gender

Gender	Frequency	percentage
Male	21	19.3
Female	88	80.7
Total	109	100.0

Table 4.3 show frequency distribution of gender out of 109 participants 21(19.3%) were male and 88(80.7%) were females.

Table 4.4 cross table of Gender

		Male	Female	Total	P-Value
No of gallstones on USG	Single	10	30	40	0.248
	Multiple	11	58	69	
Total		21	88	109	

Table 4.4 and Figure 4.2 show 10 male and 30 female had a single gallstones, while 11 male and 58 female had multiple gallstones. The number of gallstones on USG did not have significant correlation with gender, with a p-value of 0.248 ($p > 0.05$).

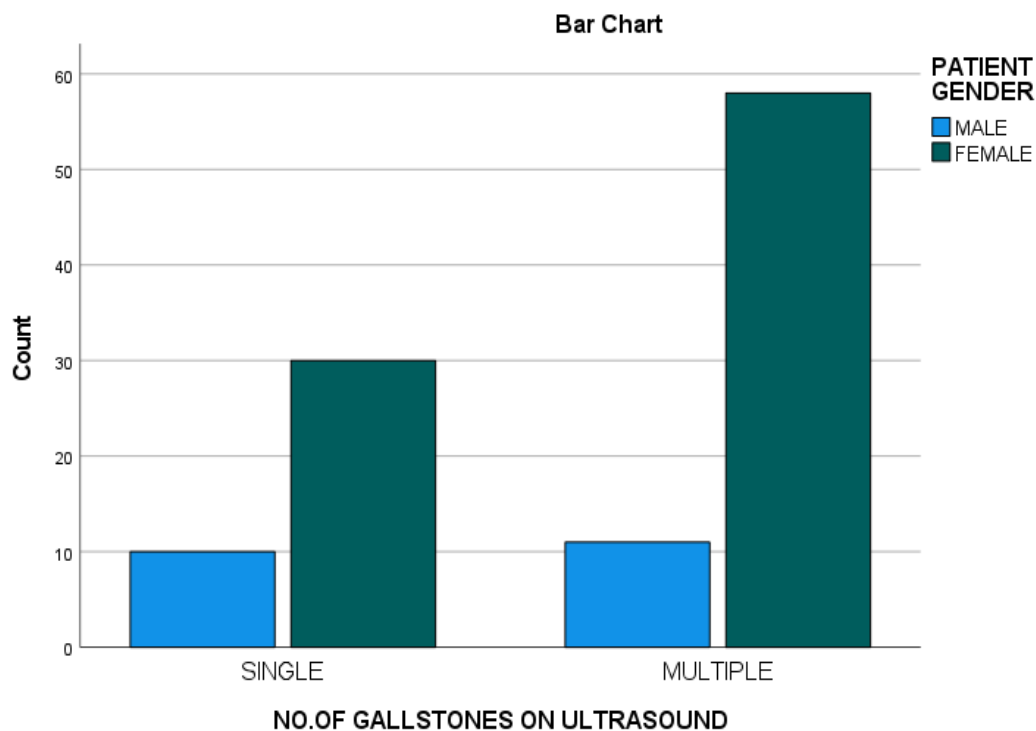


Figure 4.2 Bar chart of patient gender

Table 4.5 Frequency Distribution of Family History

Family History	Frequency	Percentage
Yes	61	56.0
No	48	44.0
Total	109	100.0

Table and figure 4.5 shows that out of 109 patients, 61(56.0%) had a family history and 48(44.0%) had not family history.

Table 4.6 Cross table of family history

		Yes	No	Total	P-Value
No of gallstones on USG	Single	18	22	40	0.079
	Multiple	43	26	69	
Total		61	48	109	

Table 4.6 and figure 4.3 show that there was no significant correlation between No. of gallstones on USG and family history with p-value of 0.079 ($p > 0.05$). Among 109 individuals, 61 with a family history and 48 without,

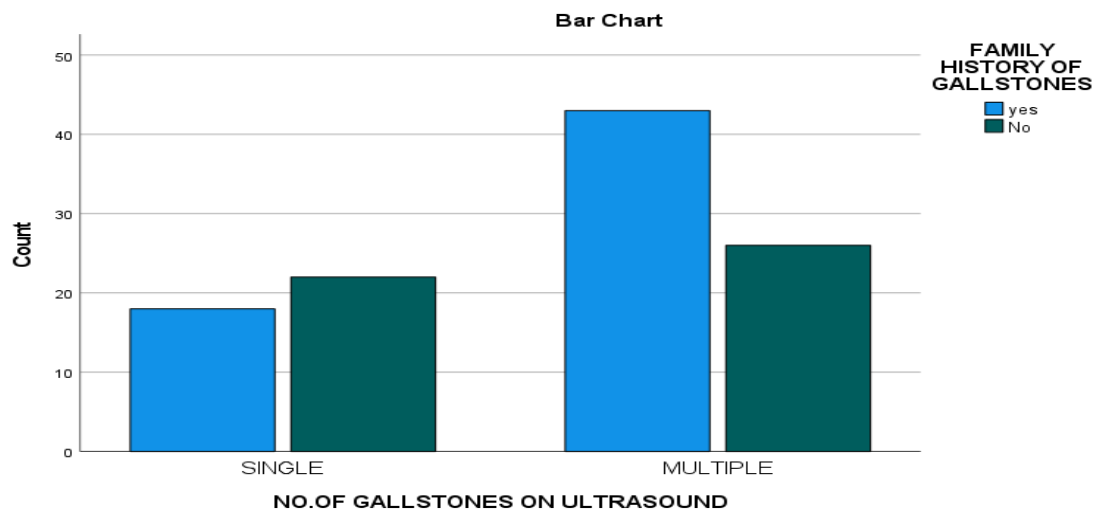


Figure 4.3 Bar chart of family history

Table 4.7 Frequency distribution of BMI

BMI normal	Frequency	Percentage
Yes	46	42.2
No	63	57.8
Total	109	100.0

Table 4.7 show frequency distribution of BMI. Out of 109 patient 46(42.2) with normal BMI and 63(57.8%) with abnormal BMI.

Table 4.8 Cross table of BMI

		Yes	No	Total	P-Value
No of gallstones on USG	Single	22	18	40	0.039
	Multiple	24	45	69	
Total		46	63	109	

Table 4.8 and figure 4.4 show that there was a significant correlation between BMI and No.of gallstones on USG with p- value of 0.039 ($p < 0.05$) and 109 patients were more likely to have multiple gallstones if there BMI was higher.

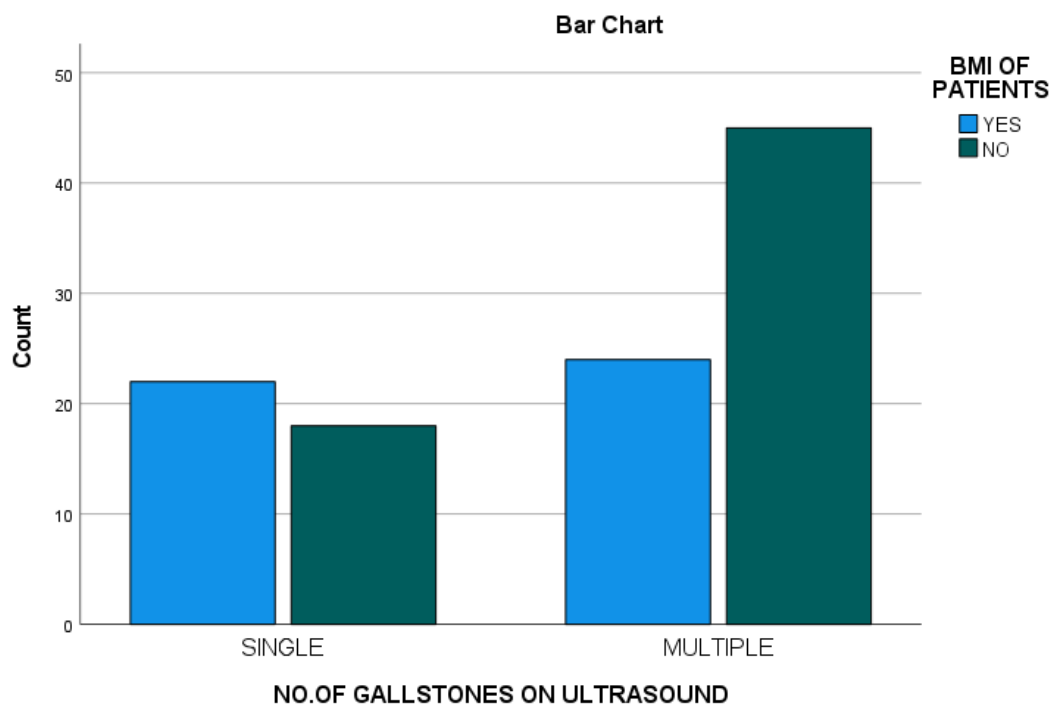


Figure 4.4 Bar chart of BMI

Table 4.9 frequency distribution of high cholesterol

High cholesterol	Frequency	Percentage
Yes	64	58.7
No	45	41.3
Total	109	100.0

Table 4.9 show frequency distribution of high cholesterol. Out of 109 patient 64(58.7%) had high cholesterol and 45(41.3%) had normal cholesterol level.

Table 4.10 Cross table of high cholesterol

		Yes	No	Total	P-Value
No of gallstones on USG	Single	26	14	40	0.310
	Multiple	38	31	69	
Total		64	45	109	

Table 4.10 and figure 4.5 show that there was no significant correlation between no of gallstones on USG with high cholesterol with a p-value of 0.310 ($p > 0.05$). Among 64 had high cholesterol and 45 had normal cholesterol.

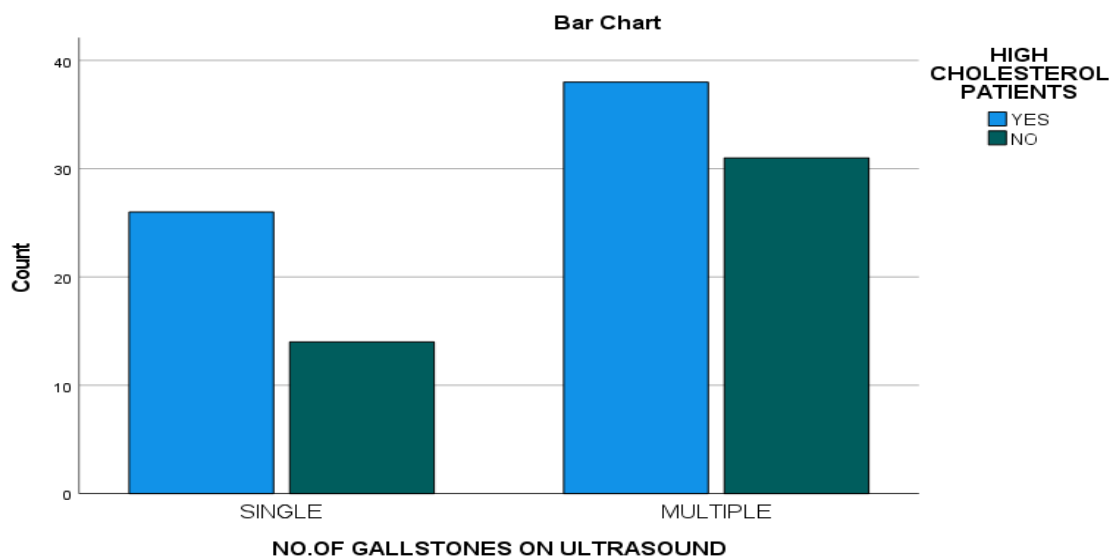


Figure 4.5 Bar chart of high cholesterol

Table 4.11 Frequency distribution of Diabetic patient

Diabetic	Frequency	Percentage
Yes	28	25.7
No	81	74.3
Total	109	100.0

Table 4.11 show frequency distribution of diabetic patient. Out of 109 patient 28(25.7%) were diabetic and 81(74.3%) were not diabetic.

Table 4.12 Cross table of Diabetic patient

		Yes	No	Total	P-Value
No of gallstones on USG	Single	9	31	40	0.295
	Multiple	22	47	69	
Total		31	78	109	

Table 4.12 and figure 4.6 show that there is no significant correlation between no. of gallstones on USG with diabetes with p-value of 0.295 ($p > 0.05$). Among 109 patient 31 had diabetes and 78 had no diabetes.

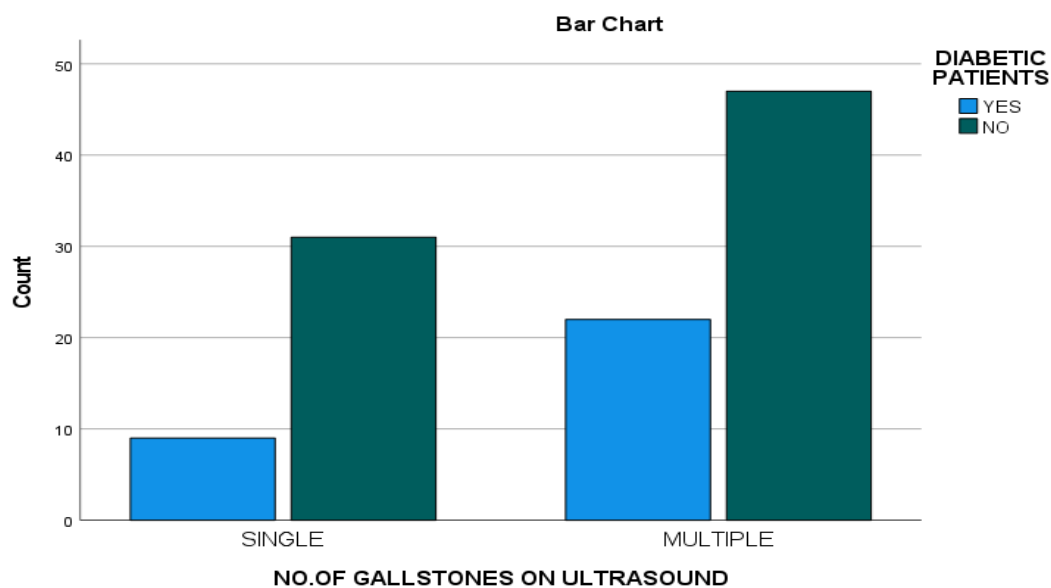


Figure 4.6 Bar chart of Diabetic patients

Table 4.13 Frequency distribution of hypertensive patient

Hypertension	Frequency	Percentage
Yes	67	61.5
No	42	38.5
Total	109	100.0

Table 4.13 show frequency distribution of hypertensive patient. Out of 109 patient 67(61.5%) had hypertension and 42(38.5%) had not hypertension.

Table 4.14 Cross table of hypertensive patient

		Yes	No	Total	P-Value
No of gallstones on USG	Single	23	17	40	0.517
	Multiple	44	25	69	
Total		67	42	109	

Table 4.14 and figure 4.7 show that there is no significant correlation between no. of gallstones on USG and hypertension with p-value 0.517 ($p > 0.05$). Among 109 patient 67 had hypertension and 42 had not hypertension.

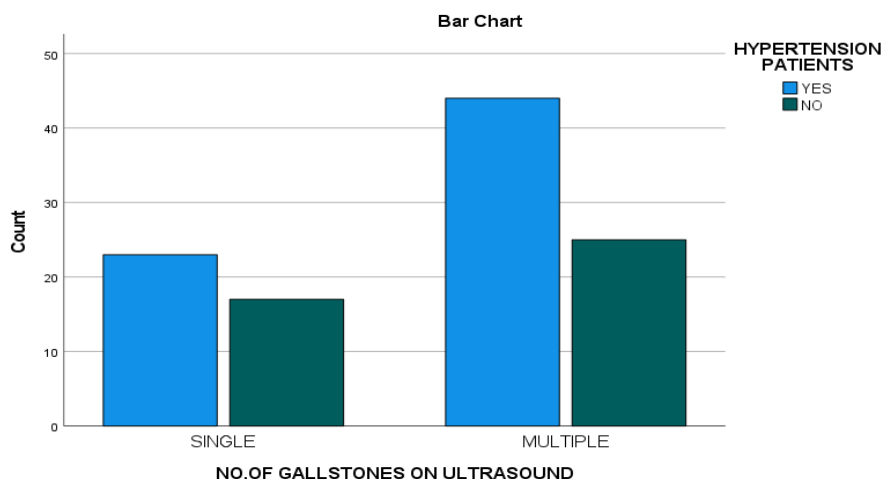


Figure 4.7 Bar chart of hypertensive patient

DISCUSSION

A cross-sectional study analyzed the relation of demographics and risk factors with the ultrasound findings of gallstones number among patients with cholelithiasis. The study evaluates the relation of variables with gallstones number and revealed that which variable showing significant correlation with the number of gallstones. The findings indicated that only BMI showing statistically significant correlation with gallstones number (p= 0.039). Other variables age, gender, family history, high cholesterol, diabetes, and hypertension in comparison to BMI showed no significant correlation with the number of gallstones (p=0.05).

In our study, the association of age with number of gallstones lack significant correlation(p=0.684) in contrast to other studies reported that the association of gallstones increases with aging, specifically in fourth and fifth decades of life (Rahman, Iqbal et al. 2022, Jones, Weir et al. 2024). This variation is due to the inclusion criteria which includes patients who already diagnosed with cholelithiasis, small sample size, and narrow age-related incidence.

In the same way, gender also did not show any significance with gallstones number (p=0.248), despite many studies revealed that there is high prevalence of cholelithiasis in females (Shahzad, Waqar et al. 2020), but once stones develop, gender does not specify the number of gallstone whether they are single or multiple.

Likewise, family history also did not show a statistical correlation (p=0.079). In our study, 56% participants showed positive response of

family history. This finding correlated with this study (Nasir, Zulfiqar et al. 2021) which evaluate the prevalence of cholelithiasis in relation to family history but compared with environmental and lifestyle factors that influence genetic predisposition.

BMI is the only variable which showed the most significant correlation with the number of gallstones. The patients who have high BMI were more prone to having multiple gallstones. This finding relates with previous studies that obesity boost up the cholesterol deposition and impairs the gallbladder function, which leads to multiple stone formation (Parra-Landazury, Cordova-Gallardo et al. 2021, Paudel, Thapa et al. 2024). Our study reveals that high BMI is the main risk factor which increases the risk of gallstone and severity of disease.

Despite there is biochemical relation between cholesterol and gallstones formation as discussed in this study (Atamanalp, Keles et al. 2013). Unexpectedly, in our study high cholesterol levels in patients did not significantly correlate with gallstones number(p=0.310). There is possibility that cholesterol and metabolic factors promotes the formation of gallstones but not play role in the stone multiplicity.

Similarly, other factors diabetes(p=0.295) and hypertension (p=0.517) also did not show significantly statistical correlation with the gallstone number in compare to previous studies (Ali, Ahamad et al. 2018, Wang, Hu et al. 2022), this divergence with previous studies may be due to the small sample size and may be due to the

focus on number of stones instead of presence of stones in gallbladder.

On the whole, our study reveals the importance of BMI that only this factor is showing a significantly correlation in cholelithiasis disease, gallstone formation and stone multiplicity. While other factors may not influence the stone multiplicity but playing a role of risk factor in the formation of gallstones.

CONCLUSION:

Our study concludes, that among the demographics and associated risk factors there is only one main factor BMI which is showing an important role and statistically significant in gallstones disease severity and multiplicity of stones number detected on ultrasound. Age, gender, family history, high cholesterol, diabetes and hypertension not showing significant correlation with multiplicity of stones.

The results evaluate that obese patient are more prone to this disease and obesity is not only a risk factor for causing cholelithiasis but also increases the severity of disease.

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