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Prevalence of Cholelithiasis Among Nigerians: A Prospective Sonographic Study In A Tertiary Center In Sokoto, Northwest Nigeria

Umar Muktar [1*], *and Farouk Kabir Umar* [2]

[1] Surgery Department, Usmanu Danfodiyo University Teaching Hospital Sokoto, Nigeria.
[2] Radiology Department, Usmanu Danfodiyo University Teaching Hospital Sokoto, Nigeria.

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***Corresponding Author:**
Umar Muktar
E-mail:
umarmuktardr@gmail.com

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ABSTRACT

Gallstone is a common and major biliary disease of modern society and is thought to be rare among Asians and the Black population. However, this narrative may also be changing with the increasing westernization of the African diet and changing lifestyle. We aimed to evaluate the sonographic prevalence of gallstones in Sokoto, North-west Nigeria. This was a descriptive, prospective study. Socio-demographic, clinical and sonographic data of all consenting patients presenting to the radiology department of Usmanu Danfodiyo University Teaching Hospital (UDUTH) Sokoto for an abdominal ultrasound between April 2024 and September 2024 were prospectively collected using a structured proforma. Statistical significance was set at a p-value of <0.05. There were 1456 who met the inclusion criteria and thus participated in the study. The majority (sixty-nine per cent) were females, the mean age was 38.3±15.0 years, and forty-nine per cent were above 40 years. The majority had a normal body mass index (BMI). The number of patients with cholelithiasis was 52, giving a prevalence of 3.57%. Prevalence among females, 4.5%, was significantly higher than that among males, 1.6% (p=0.001). Likewise, prevalence was significantly higher among overweight (6.5%) and obese (8.2%) patients than in standard (1.6%) and underweight patients (0.9%). The prevalence was observed to rise with increasing age, higher in diabetic patients and those with a family history of gallstones; however, these observed differences were not statistically significant. Cholelithiasis remains a relatively uncommon condition in our setting. Female gender and obesity significantly increased the odds of developing cholelithiasis.

Keywords: Cholelithiasis, Gallstones, Nigerians, Native black population.

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1. Introduction

Gallstones are precipitations of the bile constituents in the biliary tree, usually in the gallbladder, occurring in a background of imbalance of its chemical composition. The disease is old and has been known to humans for over a thousand years BC when it was demonstrated in Egyptian mummies (Berci, 2004). Gallstones are seen worldwide with a highly variable geographic prevalence (Cao & Eslick, 2018). It's a significant health problem in modern society, with a prevalence of 10-15% among the adult white population in high-income countries (Marschall & Einarsson, 2007). The prevalence reaches an epidemic proportion of 73% among the adult female American Pima Indians, while 30% and 64% are seen in males and females, respectively, of other American Indian populations (Everhart et al., 2002; Marschall & Einarsson, 2007). The burden is substantial, with about 750,000 cholecystectomies performed yearly in the US, costing the economy about $6.5 billion annually and a yearly mortality of 1090 patients (Stinton & Shaffer, 2012). The disease is comparatively rare among Africans and Asians, with a prevalence of 3-5% (Kratzer et al., 1999). The reported associated risk factors with lithogenesis in the gallbladder include increasing age, female gender (especially during their fertile years), use of oral contraceptives, genetic predisposition, obesity, rapid weight loss, exposure to a western-type diet (high in fat, refined sugar and low in fibre), sedentary lifestyle and low physical activity level, drugs (fibric acid derivatives), and diabetes (Njeze, 2013). Among these several risk factors implicated in the formation of stones within the gallbladder, diet and lifestyle have often been postulated to partly explain the relative rarity of gallstones among Africans (Rahman, 2005). With increasing urbanization and the resultant westernization of African diet and lifestyle, the epidemiology of many non-communicable diseases hitherto rare among the African population is changing. We postulate that there may be a corresponding increase in the prevalence of gallstones among Africans. Ultrasonography, a non-invasive and safe imaging modality, is the most common in diagnosing gallstones. It is a dynamic procedure with a sensitivity of 95% and specificity of 93% for stones of 2mm with a high diagnostic accuracy. It is ideal for determining the point prevalence of gallstones in a population (Everhart et al., 2002). This study highlights the ultrasonographic prevalence and risk factors for gallstone disease among patients presenting for transabdominal ultrasound in a referral center in Northwestern Nigeria.

- **Research questions**

This study aims to answer the following questions:

1. What is the hospital prevalence of gallstones in our center?
2. What are the socio-demographic distributions of gallstones in Sokoto?

- **Aims and Objectives**

Aim: To describe the sonographic prevalence of gallstones in Sokoto, Nigeria.
Specific objectives: To determine

1. The hospital sonographic prevalence of gallstones in our hospital.
2. The socio-demographic distribution of gallstones amongst patients in Sokoto.

2. Patients and Methods

2. 1. Study design

This was a prospective descriptive single-center study. The study was conducted over a six-month duration.

2. 2. Study setting

This study was conducted at the radiology department of Usmanu Danfodiyo University Teaching Hospital (UDUTH), Sokoto, and Sokoto state. UDUTH is an 850-bed tertiary hospital located in Sokoto metropolis rendering specialist care to patients from Sokoto, Kebbi, Zamfara, Katsina, and parts of Niger state. The population is not immune to increasing consumption of foods rich in fats and oil, saturated fats of animal origin, calorie-based sweeteners and reduced physical activity across the West African subregion (Mbogori & Mucherah, 2019).

2. 3. Study population

2. 3. 1. Inclusion Criteria

i. All patients presenting to the radiology department for an abdominopelvic ultrasound, irrespective of the indication.

2. 3. 2. Exclusion Criteria

i. Patients who have had previous cholecystectomy.
ii. Patients who withheld consent.

2. 4. Data collection

Data was collected using a uniform predesigned proforma and entered into a spreadsheet. Information to be obtained will include socio-demographic variables, clinicopathologic data indicating abdominopelvic ultrasound and major ultrasound findings. The Body Mass Index (BMI) was also documented. The BMI was calculated as the ratio of the patient's weight to squared height (in Kg/m^2). The patient's BMI was further classified according to World Health Organization (WHO) stratification into the following groups: obese (≥30.0), overweight (25.0- 29.9), normal weight (18.5- 24.9) and underweight (< 18.5). A transabdominal ultrasound scan was performed by the radiologists at the radiology department using both low (3-5MHz) and high (7.5MHz) resolutions ultrasound transducers of the MINDRAY DIAGNOSTIC ULTRASOUND SYSTEM, MODEL DC-3, and VERSION TW.FS.9 B. DN (Made in China, 03/2012) set to the 2D mode. The patient was asked to lie on the examination couch and expose the abdomen from the xiphisternum to the symphysis pubis. Ultrasound gel was generously applied over the abdomen as a complaint. The patient's abdomen was then scanned in sagittal, coronal and oblique planes, emphasising the right hypochondriac region. Gallstones on ultrasound were defined as echogenic structures casting posterior acoustic shadowing, demonstrated within the anechoic gallbladder luminal content. The number and sizes of the gallstones were measured. The presence or absence of cholecystitis (thickened gallbladder wall >3mm) will also be noted. The applied gel was cleaned with tissue paper, and the patient was asked to dress properly and sit up. The sonographic findings were explained to the patient before discharge to the appropriate clinic.
Data collected was collated and imputed into the Statistical Package for Social Sciences Software for analysis.

2. 5. Sample size determination

The minimum size of the sample was calculated using the Kish Leslie equation suitable for a cross-sectional study (Wiegand, 1968).

$$n = Z^2 x\ p\ (\ 1 - p\ )/d^2 \qquad (1)$$

Where:

n = Minimum sample size.

z = standard error of the mean which corresponds to 95% confidence level (standard value of 1.96).

p = The prevalence is unknown for the target population; we assumed a 50% prevalence to obtain the maximum sample size.
d = margin of error at 5% (standard value of 0.05).
n= 1.96^2 x 0.5 (1-0.5) / $(0.05)^2$= 385 participants.

2. 6. Data analysis

Continuous variables were presented using mean and standard deviation (median and interquartile range). Categorical data will be analyzed using proportions. Charts and tables will be used to demonstrate the frequency distribution of the variables. Comparative analysis of numerical and categorical variables was done using the independent t-test and Chi-Square (or Fisher's test), respectively. Reporting of data obtained from this study will follow the STROBE guideline. Statistical significance will be set at a p-value of <0.05. IBM SPSS Version 25.0 will be used to analyze all data obtained from the study.

2. 7. Ethical approval

The UDUTH hospital research and ethics committee issued and applied ethical clearance. All patients were granted informed consent. Confidentiality of patient information was ensured.

3. Results

3. 1. Patient Demographics

There were 1465 who had abdominal ultrasounds in the period under review; however, 1456 were selected based on the inclusion criteria and thus participated in the study. The majority were females (sixty-nine per cent). The average age was 38.3±15 years, and forty-nine per cent were above 40 years. The majority had a body mass index (BMI) within standard reference. Table 1 summarizes the patient's demographics.

Table 1. Patients' demographics

Variable	Number	Percentage
Age Groups		
<20	266	18.26923
20-40	480	32.96703
>40	710	48.76374
Sex		
Male	447	30.70055
Female	1009	69.29945
BMI		
<18.5	230	15.7967
18.5-24.9	630	43.26923
25-29-9	511	35.09615
≥30	85	5.837912
Family History		
Yes	25	1.717033
No	1431	98.28297
Diabetes		
Yes	148	10.16484
No	1308	89.83516
Parity (Females Alone)		
0	280	27.75025
1--5	520	51.53617
>5	209	20.71358

3. 2. Prevalence of Gallstones

The number of patients with cholelithiasis was 52, giving a prevalence of 3.57%. Among these patients, 32 had gallstones without evidence of gallbladder inflammation, and 10 had sludge. Table 2 summarizes the prevalence of cholelithiasis in the cohort of patients.

Table 2. Prevalence of Cholelithiasis

Finding	Frequency (N)	Prevalence %
Normal	1404	96.42857
Gall Stone	32	2.197802
Gall Bladder Sludge	10	0.686813
Calculous Cholecystitis	10	0.686813

3. 3. Analysis of Prevalence among different Demographic Cohorts

Prevalence among females (4.5%) was significantly higher than that among males, 1.6% (p=0.001). Similarly, the prevalence among overweight (6.5%) and obese (8.2%) patients was statistically significantly higher than in standard (1.6%) and underweight patients (0.9%). The prevalence was observed to rise with increasing age, higher in diabetic patients and those with a family history of gallstones; however, these observations were not significant. Table 3 summarizes the univariate analysis of prevalence and the demographic variables.

Table 3. Univariate analysis of prevalence and the demographic variables

Variable	Frequency (N)	Number With Cholelithiasis	Prevalence Of Cholelithiasis	Or	P Value
Sex					
Female	447	45	4.459861	14.51103	**0.001**
Male	1009	7	1.565996		
Bmi					
<18.5	230	2	0.869565		
18.5-24.9	630	10	1.587302	4.809843	**0.04**
25-29-9	511	33	6.457926		
≥30	85	7	8.235294		
Family History					
Yes	25	2	8	2.2896	0.61
No	1431	50	3.49406		
Diabetes					
Yes	148	8	5.405405	1.60688	0.82
No	1308	44	3.363914		
Parity (Females Alone)					
0	280	11	3.928571		
1--5	520	24	4.615385	1.18718	0.78
>5	209	10	4.784689		
Age Groups					
<20	266	3	1.12782		
20-40	480	14	2.916667		
>40	710	35	4.929577		
Age Groups					
≤40	746	17	2.27882	2.163215	0.58
>40	710	35	4.929577		

4. Discussion

The literature is replete with reports of marked geographic variation in the prevalence of gallstones. Gallstone is one of the non-communicable diseases with a high prevalence in high-income countries. It is thought to be uncommon in low and middle-income countries where the population traditionally consumes a cereal-based diet (Schwesinger et al., 1999). Epidemiologic ultrasound studies demonstrate a difference in prevalence based on racial background, with 10-15% seen in adult Europeans while 3-5% reported among African and Asian populations (Kratzer et al., 1999). Similarly, in the US, the racial and gender differences in prevalence were reported, with 5% seen among non-Hispanic Black men, while prevalence was as high as 27% among Mexican-American women (Everhart et al., 1999). Gallstone disease has been described in epidemic proportions among the American Indians, more so among the American Pima Indians, where the prevalence among adult females was reported to be 73% (Sampliner et al., 1970). The reported prevalence in the Male Pima Indians was 30%, while other Female American Indians were 64% (Everhart et al., 2002). In the index cohort study of native black patients in Sokoto, 1456 patients (n = 1009 women, 69.3%; 447 men, 30.7%) were prospectively evaluated, and the study showed that cholelithiasis may still be a relatively rare occurrence, with only 3.6% of the population having the disease. These findings are consistent with reported figures from most studies done among native African populations. The prevalence of cholelithiasis was reported to be 2.1% in Ibadan (Nigeria) (Sampliner et al., 1970), 4% in Tunisia (Safer et al., 2000), 5.2% in Sudan (Bagi Abdel et al., 1991), 5.9% in Ghana and 6.0% in South Africa (Walker et al., 1989). The observed low prevalence rate of cholelithiasis in this study and reported from previous studies in African populations is likely a combination of nature and nurture, i.e., genetic, dietary and other environmental factors thought to discourage the formation of stones in the biliary tree. There is a consensus in the literature that advancing age is a significant risk factor for gallstones, increasing 4-10 times with age (Stinton & Shaffer, 2012). Older individuals have a longer duration of exposure to the adverse effects of the causative environmental factors and thus may account for the increased relative risk (Njeze, 2013). Our study revealed an increasing prevalence of ageing; however, a univariate analysis of patients under 40 years and those above 40 did not show a statistically significant association between age and the prevalence of gallstones (p=0.58). This finding is consistent with previous studies worldwide where the prevalence of gallstones increases with ageing (Stinton & Shaffer, 2012). Population dynamics could explain our cohort's lack of statistical significance, where life expectancy is short. Different workers have proposed theories to explain the etiopathogenesis of the increasing prevalence of gallstones with age. Bertolotti propounded that the increasing prevalence resulted from increased biliary saturation with age, resulting from a decline in the activity of cholesterol 7α hydroxylase, a known rate-limiting enzyme in bile acid synthesis (Bertolotti et al., 1993). The activity of intestinal bacteria-derived 7α dihydroxylation increases with age with resultant increased production of deoxycholic acid in bile and thus increased lithogenesis with age (Einarsson et al., 1985). Gender was an important risk factor for gallstones in our study population, with females having a higher odds of developing cholelithiasis (p=0.001). This is consistent with reports in the majority of studies found in the literature (Kratzer et al., 1999). It is noteworthy that worldwide, irrespective of the stone prevalence rate, women are reported to have at least twice the prevalence of gallstones in men. This is true to a lesser extent in the postmenopausal years; however, the observed gender preponderance narrows with advancing age, but the sex difference narrows with increasing age (Njeze, 2013). The effect of female hormones, endogenous or exogenous, on bile acid synthesis, and gallbladder wall motility are thought to be responsible for the preponderance in the female gender (Njeze, 2013). A notable deviation from this general consensus in literature is a Taiwan study where no statistical significance was found between the prevalence of cholelithiasis and gender (Chen et al., 2006). The more commonly found pigment stones in that population have been offered as a possible explanation for this exception. As stated above, cholesterol stones preponderance in the female gender is driven by the effects of the female hormones which is not true for pigment stones, thus the positive effect of these hormones was obviously blurred by the preponderance of pigment stones in the Taiwan study (Chen et al., 2006; Kratzer et al., 1999). The index study demonstrated increased odds of

cholelithiasis with increasing parity; however, on univariate analysis, this was not statistically significant. Most of the previous authors have demonstrated a positive association between the prevalence of gallstones and parity consistent with the findings in our study (Eze et al., 2017; Gyedu et al., 2015). In contrast, there are some studies from Europe that could not verify these findings (Caroli-Bosc et al., 1999; Walcher et al., 2005). A plausible explanation for these observed differences could be thought to be due to differences in fertility status among women in the African and European population. In the later studies, most women have 2-3 children with higher interpregnancy intervals. However, in a recent meta-analysis and systematic review by Salari et al., they concluded that there is a positive relationship between pregnancy and gallstones (Salari et al., 2023), stating the effect of estrogen on cholesterol saturation and the effect of progesterone on gallbladder contractility as possible causes. Obesity is a key risk factor for developing gallstones, irrespective of gender (Eze et al., 2017; Gyedu et al., 2015; Stinton & Shaffer, 2012). Our findings were consistent with this observation, with a significant odd among patients with a BMI less than 25 compared to those with a BMI of at least 25 (p=0.04). On the contrary, few studies have found no association between BMI and gallstones (Gyedu et al., 2015) or even reduced odds of cholelithiasis among individuals with higher BMI (Salinas et al., 2004). Diabetes mellitus is thought to be positively associated with increased lithogenesis, resulting in increased cholesterol saturation in bile (Ratheesh et al., 2023). In our study, diabetes mellitus was associated with non-significant decreased odds of cholelithiasis on univariate analysis. Patients who admitted to being diabetic had 1.6 odds of having gallstones; however, this was not statistically significant. Not conducting a blood glucose test on our population could have missed patients with undiagnosed diabetes mellitus. This could have affected our results and may be responsible for the non-significance of the finding. Our study findings suggest that those with a family history had increased odds of developing gallstones; however, this was not statistically significant (p=0.61). The literature is dotted with reports from similar studies that support our findings (Attili et al., 2005; Gyedu et al., 2015). Attili et al., in their study on this subject, found that the strongest association was found in first-degree relatives, more so with mothers. There was no association between the prevalence of gallstones in the index case and his/her brother or spouse. The findings of a relationship between family histories noted in this study must be interpreted cautiously. Further studies with a more elaborate screening of relatives of gallstone patients are required to elucidate this relationship.

5. Conclusion

Cholelithiasis still remains a relatively uncommon condition in our setting; however, it is higher than reports from old literature. Female gender and obesity significantly increased the odds of developing cholelithiasis. Other risk factors for developing cholelithiasis in Sokoto included ageing, diabetes mellitus, family history and multiparity. Eating healthy and exercising physically to prevent obesity is key to preventing it.

Data Availability

The data for the research is stored in completed proformas and on the personal computer of the corresponding author. The data is available on request.

Author Contributions

"**Conceptualization**, Umar Muktar.; **Methodology,** Umar Muktar and Farouk Kabir Umar.; **software**, Umar Muktar.; validation, Umar Muktar and Farouk Kabir Umar.; **formal analysis**, Umar Muktar.; investigation, Umar Muktar and Farouk Kabir Umar.; **resources**, Umar Muktar and Farouk Kabir Umar.; **data curation**, Umar Muktar.; **writing—original draft preparation**, Umar Muktar.; **writing—review and editing**, Umar Muktar.; **visualization**, Umar Muktar.; **supervision**, Umar

Muktar.; **project administration**, Umar Muktar and Farouk Kabir Umar.; **funding acquisition**, Umar Muktar and Farouk Kabir Umar. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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