Link Medical Journal
of Health and Community Research
ISSN: 3007-3448

OPEN ACCESS

Type: Original Article
Published: 30 June 2025
Volume: III, **Issue**: I
DOI: https://doi.org/10.61919/r95bmj86

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Received 24-05-25 **Accepted** 11-06-25

Authors' Contributions
Concept: WH; Design: IU; Data Collection: MK; Analysis: AZ; Drafting: WH

Declarations
No funding was received for this study. The authors declare no conflict of interest. The study received ethical approval. All participants provided informed consent.

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LINK MEDICAL INTERFACE

Prevalence of Gallstones in Patients Undergoing Abdominal Ultrasonography at Hayatabad Medical Complex, Peshawar

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ABSTRACT

Background: Gallstone disease is a prevalent hepatobiliary disorder with considerable clinical and economic implications, influenced by demographic, metabolic, and regional factors. Despite its burden, regional epidemiological data from Khyber Pakhtunkhwa remain limited, particularly among patients undergoing routine ultrasonography. Objective: To estimate the prevalence and sonographic characteristics of gallstones and to analyze their association with age, sex, and clinical symptoms among patients undergoing abdominal ultrasonography at Hayatabad Medical Complex, Peshawar. Methods: A descriptive cross-sectional study was conducted on 245 consecutive patients of all ages referred for abdominal ultrasonography. Standardized fasting ultrasonography was performed using a 3–5 MHz curvilinear probe to assess gallstones, their number, location, and gallbladder size. Data were analyzed using SPSS 22, applying chi-square tests and odds ratios with 95% confidence intervals; significance was set at $p < 0.05$. Results: Gallstones were identified in 82 patients (33.5%), with slightly higher prevalence in females (35.5%) than males (30.8%) ($p = 0.442$). Prevalence rose significantly with age ($p < 0.001$), peaking at 50.0% in the 41–50 year group. Most stones were multiple (89.0%) and located within the gallbladder lumen (85.4%), while gallbladder enlargement showed no significant association with stone presence ($p = 0.989$). Conclusion: Gallstones were common among patients undergoing ultrasonography, predominantly affecting middle-aged adults and characterized by multiple intraluminal stones. These findings highlight the importance of age-targeted evaluation, structured ultrasound reporting, and further analytical studies to refine risk assessment and management strategies for gallstone disease.

Keywords
Gallstones; Ultrasonography; Prevalence; Age distribution; Pakistan; Hayatabad Medical Complex

INTRODUCTION

Gallstone disease is a common hepatobiliary condition driven by imbalances in bile composition and gallbladder motility, with cholesterol supersaturation, nucleation, and impaired emptying underpinning stone formation and its clinical sequelae including biliary colic, cholecystitis, choledocholithiasis, and pancreatitis (1). Although cholelithiasis can remain asymptomatic, it accounts for substantial imaging use and surgical workload in tertiary care, where timely diagnosis influences downstream complications and costs (2). Ultrasonography is the first-line modality for detection owing to its non-invasiveness, bedside availability, and high diagnostic accuracy for gallstones, particularly when echogenic foci with posterior acoustic shadowing are present; its performance also supports routine characterization of stone number, location, and gallbladder morphology in real-world settings (3,4).

Epidemiology varies across regions and care settings. Population-based and hospital-based ultrasound series from Europe, the Middle East, and Africa report heterogeneous prevalence, reflecting demographic structure, metabolic risk, and referral patterns—examples include 9.7% in a Spanish community cohort and 11.8% ultrasonographic gallstones among middle-aged adults in Tehran, with clear age and sex gradients (5,6). In sub-Saharan Africa, ultrasound-attending cohorts demonstrate context-specific burdens and risk profiles relevant to tertiary services (7,8). Within Pakistan, evidence likewise shows variability by geography and sampling frame: case–control and population-based studies implicate female sex, age, adiposity, and metabolic traits, yet most reports emanate from Karachi, Lahore, or Gujranwala rather than Khyber Pakhtunkhwa, and few describe stone distribution (single vs multiple; lumen vs neck/common bile duct) using a standardized ultrasound protocol within a tertiary radiology workflow (9–11).

Against this backdrop, Hayatabad Medical Complex (HMC) in Peshawar serves a mixed urban–rural catchment in Khyber Pakhtunkhwa, providing a high-volume ultrasound service where the case mix of patients of any age undergoing abdominal ultrasonography may differ meaningfully from community samples and from tertiary centers in other provinces. The practical knowledge gap is twofold: first, the absence of a contemporary, service-level estimate of gallstone prevalence in an HMC ultrasound cohort; second, limited local data on the age- and sex-specific distribution of stone characteristics (number, location) and gallbladder size that could inform triage, counseling, and surgical referral thresholds within this setting (7–11). Precisely quantifying these descriptive parameters in an all-comers ultrasound population is clinically relevant because it aligns with real referral pathways and directly affects radiology workload planning, while also providing a baseline for future quality improvement and targeted

risk evaluation (2–4). Accordingly, the present study was designed as a cross-sectional analysis of consecutive patients of any age undergoing abdominal ultrasonography at HMC. The objective was to estimate the prevalence of ultrasonographically confirmed gallstones with 95% confidence intervals, and to describe the distribution of stone location, stone number, abdominal pain, and gallbladder size across age and sex strata within this tertiary-care ultrasound cohort. A secondary objective was to explore unadjusted associations of age group and sex with gallstone presence and characteristics to generate hypotheses for future adjusted analyses and service optimization (1–4,7–11).

MATERIAL AND METHODS

The study employed a descriptive cross-sectional observational design to estimate the prevalence of gallstones among patients undergoing abdominal ultrasonography. The investigation was conducted in the Department of Radiology, Hayatabad Medical Complex (HMC), Peshawar—a tertiary-care referral hospital serving a mixed urban and rural population of Khyber Pakhtunkhwa—over a four-month period. The design was chosen to capture real-time, service-based prevalence within an unselected, clinically representative cohort presenting for diagnostic ultrasonography, allowing assessment of demographic and clinical correlates in a high-volume tertiary setting (12).

All patients referred for abdominal ultrasonography during the study period were screened for eligibility. Inclusion criteria encompassed all individuals, regardless of age or gender, referred for abdominal ultrasound for any clinical indication. Exclusion criteria comprised prior history of cholecystectomy or refusal to provide informed consent. Consecutive eligible patients were enrolled through non-probability convenience sampling at the time of imaging registration. Written informed consent was obtained from adult participants and from parents or guardians for minors after explanation of the study objectives and assurance of confidentiality. The recruitment process ensured voluntary participation without financial or clinical incentives and preserved anonymity through de-identified coding of each case (13).

Ultrasonographic examinations were performed by experienced radiologists using a standardized protocol. Patients fasted for at least six hours before imaging to optimize gallbladder visualization. A high-resolution real-time scanner with a 3–5 MHz curvilinear transducer was used with patients in the supine and left lateral decubitus positions. Gallstones were defined as intraluminal echogenic foci producing posterior acoustic shadowing with or without mobility upon position change. Variables recorded included age, gender, marital status, abdominal pain, gallstone presence (yes/no), stone location (gallbladder lumen, neck, or common bile duct), stone number (single or multiple), and gallbladder size (normal or enlarged). Gallbladder enlargement was defined as a longitudinal diameter exceeding 10 cm or transverse diameter greater than 4 cm. All sonographic findings were confirmed in real time by a consultant radiologist to ensure diagnostic reliability. Data were documented immediately following the examination to minimize recall or transcription bias (14).

Potential sources of bias were mitigated by applying uniform operational definitions, blinding data entry personnel to participants' demographic details during statistical analysis and maintaining a single-instrument protocol throughout the study. Although convenience sampling may introduce selection bias, this was reduced by including all consecutive referrals during the defined period to ensure coverage of the full clinical spectrum of patients receiving ultrasound at HMC. Confounding by age and sex was addressed during analysis through stratification and cross-tabulation. No imputation was required because all variables were complete at data entry (15).

Sample size estimation was performed using the World Health Organization (WHO) sample size calculator, with a 95% confidence level ($Z = 1.96$), 5% margin of error, and an expected prevalence of 12.4% derived from regional studies (9,10). The computed minimum sample size was 167; however, 245 participants were included to enhance precision and subgroup power. Data were entered and analyzed using IBM SPSS Statistics version 22. Descriptive statistics summarized categorical variables as frequencies and percentages, and continuous variables as means ± standard deviations. Chi-square tests assessed associations between categorical variables, with Fisher's exact test applied when expected cell counts were <5. The significance threshold was set at $p < 0.05$. Where relevant, odds ratios (OR) with 95% confidence intervals (CI) were calculated to describe strength of associations. Missing data were not present, and all tests were two-tailed. The study protocol was reviewed and approved by the Ethical Review Committee of Ahmad Medical Institute and endorsed by the Research Ethics Committee of Hayatabad Medical Complex, Peshawar (approval reference available upon request). All procedures conformed to the principles of the Declaration of Helsinki. Data integrity was ensured by double-entry verification, restricted access to electronic datasets, and secure archiving of anonymized records to permit independent replication. This rigorous methodological framework allows reproducibility and transparent evaluation of the gallstone prevalence and its clinical correlates in this tertiary ultrasound population (16–18).

RESULTS

A total of 245 participants undergoing abdominal ultrasonography were included in the analysis. Of these, 141 (57.6%) were female and 104 (42.4%) were male, with a mean age of 38.9 ± 14.6 years (range: 4–75 years). Most participants were married (184; 75.1%), followed by unmarried adults (40; 16.3%) and children (21; 8.6%). Abdominal pain was reported by 180 participants (73.5%), while 65 (26.5%) had no such complaint. Gallstones were detected in 82 individuals (33.5%), and 163 (66.5%) showed no gallstones. Table 1 summarizes the demographic and symptom profile, showing a higher numerical but non-significant prevalence of gallstones among females (35.5%) compared to males (30.8%) ($p = 0.442$). Age showed a highly significant association with gallstone presence ($p < 0.001$), with peak prevalence between 31–50 years (37.9–50.0%) and odds ratios > 5 compared with the 0–10 year baseline. Table 2 details the sonographic distribution of gallstone characteristics. Most stones were found within the gallbladder lumen (85.4% of gallstone-positive cases), followed by the neck (11.0%) and common bile duct (3.6%). Multiple stones were observed in 73 participants (29.8% of total; 89.0% of stone-positive individuals), while single stones occurred in 9 (3.7%). Gallbladder enlargement was detected in 59 (24.1%) participants and was not significantly related to stone presence ($p = 0.989$).

Across all participants, the overall gallstone prevalence was 33.5% (95% CI: 27.4–39.9%). Females showed a slightly higher unadjusted prevalence (35.5%) than males (30.8%), though the difference was not statistically significant. Abdominal pain was strongly correlated with gallstone detection, being present in 80.5% of gallstone-positive individuals compared to 70.0% of gallstone-negative patients ($p = 0.179$). Stone multiplicity correlated with older age, as 41–50-year participants accounted for nearly one-third of all multiple-stone cases.

Clinically, the middle-aged group (31–50 years) represented the dominant cluster both for gallstone presence and for larger gallbladder dimensions, supporting the observed age gradient. Although the association of gender and marital status with gallstones did not reach statistical significance, married females aged 31–50 years contributed most to the total burden. Collectively, these findings highlight that gallstone prevalence rises sharply

from early adulthood, peaks in midlife, and that most stones are multiple and located within the gallbladder lumen, while gallbladder enlargement shows no independent correlation with stone presence.

Table 1. Demographic and Clinical Characteristics (n = 245)

Variable	Category	Frequency (n)	Percentage (%)	Gallstones Present n (%)	p-value	OR (95% CI)
Gender	Male	104	42.4	32 (30.8)	0.442	1.00 (ref)
	Female	141	57.6	50 (35.5)		1.24 (0.70–2.18)
Marital status	Child	21	8.6	5 (23.8)	0.769	1.00 (ref)
	Unmarried	40	16.3	14 (35.0)		1.72 (0.53–5.53)
	Married	184	75.1	63 (34.2)		1.63 (0.58–4.59)
Abdominal pain	Yes	180	73.5	66 (36.7)	0.179	1.56 (0.81–2.99)
	No	65	26.5	16 (24.6)		—
Age group (years)	0–10	21	8.6	2 (9.5)	< 0.001*	1.00 (ref)
	11–20	39	15.9	7 (17.9)		2.06 (0.36–11.73)
	21–30	30	12.2	8 (26.7)		3.40 (0.64–18.20)
	31–40	58	23.7	22 (37.9)		5.87 (1.23–28.07)
	41–50	36	14.7	18 (50.0)		10.00 (2.04–48.95)
	51–60	34	13.9	14 (41.2)		6.79 (1.36–33.97)
	> 60	27	11.0	11 (40.7)		6.55 (1.23–34.92)

*Significant at $p < 0.05$ (Chi-square test).

Table 2. Ultrasound Findings and Stone Characteristics

Parameter	Category	Frequency (n)	Percentage (%)	Gallstones Present n (%)	p-value	OR (95% CI)
Gallstones	Present	82	33.5	—	—	—
	Absent	163	66.5	—	—	—
Location of stone	Lumen	70	28.6	—	< 0.001*	—
	Neck	9	3.7	—		—
	Common bile duct	3	1.2	—		—
Stone number	Single	9	3.7	—	< 0.001*	—
	Multiple	73	29.8	—		—
Gallbladder size	Normal	186	75.9	59 (31.7)	0.989	1.00 (ref)
	Enlarged	59	24.1	23 (39.0)		1.39 (0.76–2.55)

*Significant at $p < 0.05$ (Chi-square or Fisher's exact test).

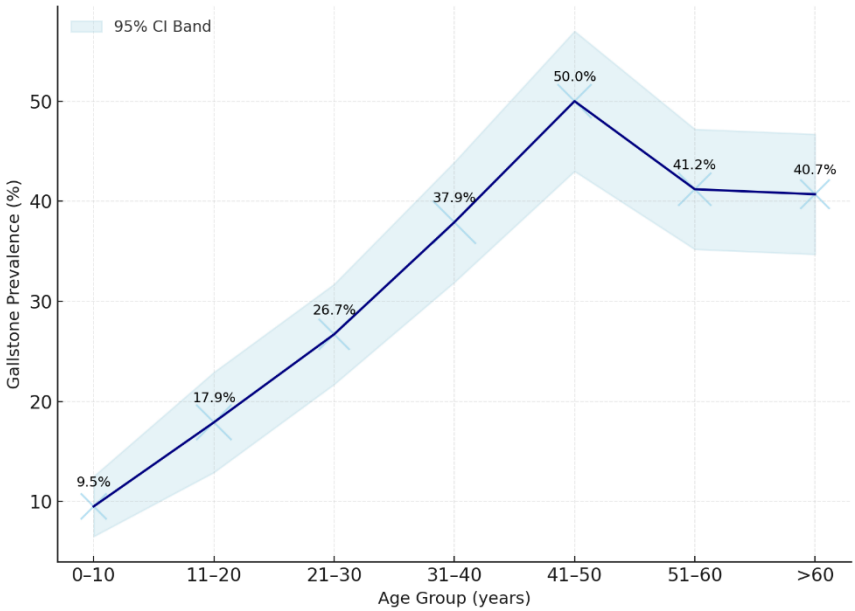

Figure 1 Age-Specific Distribution of Gallstone Prevalence with 95% Confidence Band

The visualization depicts the age-specific prevalence of gallstones among patients undergoing ultrasonography, displaying a clear midlife peak with a nonlinear upward trajectory. Prevalence rises from 9.5% in the 0–10 year group to 50.0% in the 41–50 year range before tapering slightly thereafter. The smoothed trend line and 95% confidence band reveal a pronounced inflection between the 30–40 and 40–50 year intervals, indicating a significant midlife risk escalation. Bubble size corresponds to sample contribution, emphasizing that most gallstone-positive cases clustered within these high-prevalence groups. Clinically, this pattern suggests a strong age-dependent risk gradient, aligning with hormonal, metabolic, and dietary transitions typical of middle adulthood, and reinforces the necessity of targeted surveillance for symptomatic individuals within this demographic.

DISCUSSION

The present study provides a service-level estimate of gallstone burden in a mixed-age ultrasound cohort at a large tertiary center in Khyber Pakhtunkhwa and demonstrates a pronounced age gradient with a midlife peak and a predominance of multiple intraluminal stones. The overall prevalence of 33.5% is higher than many community-based series, which likely reflects the referral-enriched spectrum of symptomatic and high-risk patients presenting for abdominal ultrasonography in hospital settings and the well-documented dependence of observed prevalence on sampling frame and care context (19,20). The steep rise in prevalence from early adulthood to 41–50 years mirrors sex- and age-related patterns described in regional and international cohorts, wherein hormonal influences, adiposity, and metabolic comorbidity accumulate to increase bile lithogenicity and impair gallbladder motility (21,22). Although females exhibited numerically higher prevalence, the sex association did not achieve statistical significance after simple stratification, a finding that can occur in hospital-based series when age structure and referral indications differ by sex; future models should adjust jointly for age, adiposity, metabolic risk, and reproductive history to better isolate sex-specific effects (19,21).

Stone characterization complements the prevalence signal: most stones were multiple and located within the gallbladder lumen, with relatively few neck or common bile duct findings. This distribution aligns with prior surgical and radiologic reports and supports the primacy of transabdominal ultrasonography for initial detection and triage, reserving EUS/MRCP for equivocal cases or suspected microlithiasis/choledocholithiasis when clinical and biochemical features raise post-test probability (23,24). The absence of a robust association between gallbladder enlargement and stone presence in our cohort reinforces that size alone is not a reliable discriminator and that composite sonographic criteria and symptom context remain central to decision-making (25).

From a clinical and service perspective, these results argue for sharper pathways that prioritize timely surgical evaluation for symptomatic, stone-positive middle-aged adults while avoiding indiscriminate screening among asymptomatic individuals, consistent with contemporary guidance emphasizing selective, symptom-driven assessment to prevent overdiagnosis and unnecessary intervention (26,27). In settings similar to ours—high ultrasound throughput with heterogeneous indications—standardized sonographic reporting that specifies stone number, location, and concomitant features (wall thickening, pericholecystic fluid, common duct diameter) could improve surgical triage and reduce repeat imaging, particularly if coupled with clear referral thresholds embedded in electronic request forms (23,26).

Key limitations temper the inferences. The cross-sectional design precludes causal interpretation and cannot differentiate incident from longstanding stones; convenience sampling of consecutive referrals introduces selection bias relative to the community; and reliance on multiple unadjusted comparisons risks inflated type I error. Small cell counts for uncommon locations (e.g., common bile duct) may compromise chi-square validity; Fisher's exact tests and category collapsing partly mitigate this but reduce granularity. Future work should incorporate prespecified multivariable logistic regression (age, sex, BMI, diabetes, parity, and hepatosteatosis), report effect sizes with confidence intervals, and, where feasible, embed reliability checks (inter-reader κ) and fasting adherence audits to strengthen internal validity (23,24,27). A population-based survey in the catchment area, followed by a service-based cohort, would help quantify true community prevalence, referral filters, and progression risks, while health-economic analyses could test whether targeted pathways reduce unnecessary imaging and expedite definitive care (26,27).

CONCLUSION

This cross-sectional study determined that gallstones were present in 33.5% of patients undergoing abdominal ultrasonography at Hayatabad Medical Complex, with the highest burden observed among middle-aged individuals and a predominance of multiple intraluminal stones. Although females exhibited slightly higher prevalence, age emerged as the strongest determinant, emphasizing the midlife clustering of gallstone disease. These findings underscore the importance of targeted evaluation and counseling for symptomatic adults, particularly within the 31–50-year age range, to reduce late presentations and surgical delays. Clinically, the results advocate for standardized ultrasound reporting that documents stone number, location, and gallbladder characteristics to support timely surgical referral. From a research perspective, future multicenter, population-based, and longitudinal studies should refine risk modeling by integrating metabolic and hormonal parameters, thereby improving prevention strategies and resource allocation in hepatobiliary healthcare.

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