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Prevalence and determinants of gallstone disease in patients undergoing abdominal ultrasound at Alexandria General Hospital

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Abstract
Background: Gallstone disease is a prevalent gastrointestinal disorder, varying globally between 5-25%. Despite its significant burden in the Middle East, Iraqi populations remain underrepresented in research, limiting healthcare planning. This study investigates gallstone prevalence and associated risk factors among patients undergoing abdominal ultrasonography at Alexandria General Hospital, Babylon, Iraq, addressing critical epidemiological knowledge gaps.
Methods: A hospital-based cross-sectional study was conducted over 12 months (January-December 2024) involving 1,247 adult patients aged ≥18 years referred for abdominal ultrasonography. Systematic random sampling selected every third eligible patient. Data collection employed structured questionnaires assessing sociodemographic characteristics, medical history, lifestyle factors, and family history. Standardized ultrasonographic examinations were performed using high-resolution equipment by experienced radiologists. Statistical analysis included descriptive statistics, bivariate analysis, and multivariable logistic regression to identify independent risk factors.
Results: The overall gallstone prevalence was 18.4% (95% CI: 16.2-20.8%), with significantly higher rates among females (23.8%) compared to males (9.4%), yielding a female-to-male ratio of 2.53:1. Age-stratified analysis revealed progressive prevalence increases: 8.2% (18-39 years), 21.1% (40-59 years), and 28.2% (≥60 years). Multivariable analysis identified female gender (adjusted OR=2.45), advanced age (adjusted OR=3.12 for ≥60 years), obesity (adjusted OR=2.67), diabetes mellitus (adjusted OR=1.84), family history (adjusted OR=2.19), physical inactivity (adjusted OR=1.52), and multiparity (adjusted OR=1.73) as independent risk factors.
Conclusion: This investigation establishes the first comprehensive epidemiological baseline for gallstone disease in Iraq, documenting substantial disease burden with clear risk factor profiles. The findings necessitate targeted prevention programs focusing on modifiable risk factors and inform evidence-based healthcare policy development for optimal resource allocation and clinical management strategies.

Keywords: Gallstone, prevalence, risk factors, ultrasonography, Iraq

Introduction
Gallstone disease, involving calculi formation within the gallbladder or bile ducts, represents a major gastrointestinal disorder affecting millions globally [1]. Epidemiological studies reveal significant prevalence variations of 5-25% across geographic regions and ethnic populations, reflecting complex interactions between genetic predisposition, environmental factors, dietary patterns, and socioeconomic determinants [2].
The pathophysiology centers on cholesterol supersaturation of bile, impaired gallbladder motility, and nucleation factors promoting crystal formation [3]. Recent research has highlighted the crucial roles of bile acid metabolism, hepatic cholesterol synthesis, and intestinal cholesterol absorption in disease pathogenesis, offering potential therapeutic targets [4]. Molecular genetics advances have identified susceptibility genes including ABCG8, CYP7A1, and LITH genes that significantly influence individual risk profiles [5].
Middle Eastern populations demonstrate considerable gallstone disease prevalence, with studies reporting rates of 12-22% in Saudi Arabia, Iran, and Turkey [6, 7]. However, Iraqi populations remain underrepresented in existing literature, creating a significant knowledge gap given their unique demographic characteristics, dietary patterns, and genetic background that may influence disease prevalence differently than neighboring countries [8].
Clinical presentation ranges from asymptomatic cholelithiasis to life-threatening complications including acute cholangitis and gallbladder perforation [9]. Approximately

80% of individuals remain asymptomatic throughout life, while 20% develop symptoms requiring medical intervention [10]. The economic burden is substantial, particularly in developing countries like Iraq where healthcare resources are limited, making prevalence understanding crucial for optimal resource allocation and healthcare planning [11].

High-resolution ultrasonography has revolutionized gallstone detection with sensitivity and specificity rates exceeding 95% and 99%, respectively [12]. This non-invasive, cost-effective diagnostic modality has become the gold standard, making population-based screening studies more feasible. The widespread availability of ultrasonography in Iraqi hospitals provides excellent opportunities for comprehensive epidemiological assessments.

Well-established risk factors include advanced age, female gender, obesity, rapid weight loss, diabetes mellitus, metabolic syndrome, inflammatory bowel disease, and certain medications including oral contraceptives and hormone replacement therapy [13, 14]. However, the relative importance and population-attributable risk of these factors vary significantly across populations, necessitating population-specific epidemiological studies.

The critical need for baseline epidemiological data in the Iraqi population, particularly in Babylon governorate, drives this research. Such data are essential for healthcare planning, resource allocation, and developing targeted prevention programs. Understanding specific risk factor profiles will inform clinical practice guidelines and enable healthcare providers to implement appropriate screening and management strategies. These findings will contribute significantly to the limited knowledge base regarding gallstone epidemiology in the Middle Eastern region and provide valuable insights for future research initiatives.

This study aims to determine gallstone disease prevalence among patients undergoing abdominal ultrasonography at Alexandria General Hospital, Babylon, Iraq, and identify associated risk factors contributing to disease development in this specific population. The research addresses a critical gap in regional epidemiological understanding while providing essential data for improving healthcare delivery and prevention strategies in Iraq.

Materials and Methods

Study design and setting

This hospital-based cross-sectional descriptive study assessed gallstone disease prevalence and associated risk factors among patients undergoing abdominal ultrasonographic examination. The investigation was conducted at Alexandria General Hospital, a 150-bed secondary care facility in Babylon governorate, Iraq, serving approximately 300,000 residents from urban and rural areas. The hospital's Radiology Department performs 6,000-8,000 abdominal ultrasounds annually, managing diverse medical and surgical cases while referring complex cases to tertiary centers. Data collection spanned 12 months (January-December 2024) to capture seasonal variations and ensure representative patient sampling.

Study population and sampling

The target population included all adult patients aged 18 years and above referred for abdominal ultrasonography during the study period. Inclusion criteria comprised:

1) Age ≥18 years
2) Babylon governorate residency for at least six months
3) Ability to provide informed consent, and
4) Undergoing abdominal ultrasonography for any clinical indication

Exclusion criteria eliminated potential confounding factors:

1) Previous cholecystectomy
2) Acute abdominal pain requiring emergency intervention
3) Pregnancy
4) Mental incapacity preventing informed consent
5) Previous gallbladder cancer history
6) Active hepatobiliary malignancy, and
7) Incomplete ultrasonographic examination due to technical factors

Sample size calculation utilized the cross-sectional study formula: $n = Z^2pq/d^2$, where Z=1.96 (95% confidence level), p=15% (expected prevalence based on regional studies), q=(1-p), and d=3% (desired precision). Accounting for 10% non-response rate, the minimum calculated sample size was 1,134 participants. To enhance statistical power and enable subgroup analyses, the final sample size was established at 1,250 participants.

Systematic random sampling ensured representative participant selection. Every third patient presenting for abdominal ultrasonography was approached for enrollment after inclusion and exclusion criteria verification. This approach minimized selection bias while maintaining practical feasibility. Random number tables determined daily sampling starting points, with consistent sampling intervals maintained throughout the study period.

Data collection procedures

Data collection employed structured, pre-tested questionnaires administered through face-to-face interviews by trained research assistants. The questionnaire development was based on extensive literature review and validated instruments from previous gallstone epidemiological studies. Content validity was established through expert review by three gastroenterologists and two epidemiologists. Reliability assessment through test-retest procedures with 50 participants achieved a Cronbach's alpha coefficient of 0.87.

The questionnaire comprised five sections:

1) Sociodemographic characteristics
2) Medical history and comorbidities
3) Lifestyle factors
4) Dietary patterns, and
5) Family history

Standardized anthropometric measurements included height, weight, waist circumference, and hip circumference using calibrated equipment. Body mass index was calculated as weight (kg) divided by height squared (m^2), with obesity defined as BMI ≥30 kg/m^2.

Variables and outcome measures

The primary outcome was gallstone disease presence determined by abdominal ultrasonography, defined by established criteria: hyperechoic foci with acoustic shadowing, gravity-dependent mobility, or wall-echo-shadow complex appearance. Secondary outcomes included gallstone size, number, and gallbladder location. Independent variables assessed as potential risk factors encompassed age, gender, body mass index, waist-to-hip ratio, educational level, occupation, smoking status, alcohol

consumption, physical activity level, dietary fat intake, diabetes mellitus, hypertension, dyslipidemia, metabolic syndrome, family history of gallstone disease, parity, hormone replacement therapy use, and oral contraceptive use.

Ultrasonographic protocol

All examinations were conducted using the available high-resolution equipment in the hospital with 3.5-5.0 MHz curved array transducers and performed by experienced radiologists with a minimum of five years of hepatobiliary imaging experience. Patients fasted for at least 8 hours prior to the examination to ensure optimal gallbladder distension. Standardized scanning protocols were followed, evaluating the gallbladder in multiple positions (supine, left lateral decubitus, sitting) to differentiate gallstones from polyps or sludge. Image quality was assessed, and suboptimal examinations due to bowel gas or patient-related factors were repeated within 48 hours.

Ethical considerations

Ethical approval was obtained from Alexandria General Hospital's Institutional Review Board and Babylon Health Directorate's Ethics Committee prior to study commencement. All procedures followed Declaration of Helsinki principles and local ethical guidelines. Written informed consent was obtained after explaining study objectives, procedures, potential risks, and benefits. Participants were assured of confidentiality and withdrawal rights without affecting medical care. Personal identifying information was removed following data collection, with participants assigned unique identification numbers ensuring anonymity.

Statistical analysis

Data were entered into Microsoft Excel databases and analyzed using SPSS version 28.0. Quality assurance procedures included double data entry by independent operators and continuous variable range checks. Descriptive statistics calculated for all variables presented categorical variables as frequencies and percentages, while continuous variables were expressed as means ± standard deviations. Bivariate analysis utilized chi-square tests for categorical variables and Student's t-test or Mann-Whitney U test for continuous variables, depending on data distribution. Multivariable logistic regression analysis identified independent gallstone disease risk factors, with results presented as adjusted odds ratios with 95% confidence intervals. Statistical significance was defined as $p<0.05$ for all two-tailed tests.

Results

Demographic characteristics

The study successfully recruited 1,247 participants, achieving a response rate of 99.8%. Participant demographics demonstrated a mean age of 47.6±15.3 years (range: 18-82 years), with a predominant female representation (62.4%, n=778). The age distribution exhibited the largest cohort within the 40-59 years category (34.2%, n=426), followed by participants aged 18-39 years (37.1%, n=463) and those ≥60 years (28.7%, n=358). Educational attainment demonstrated considerable heterogeneity, with secondary education representing the most prevalent level (38.5%, n=480), followed by university education (24.7%, n=308), primary education (22.1%, n=276), and illiteracy (14.7%, n=183).

Occupational distribution revealed housewives constituted the largest group (32.4%, n=404), followed by government employees (23.6%, n=294), private sector workers (18.9%, n=236), farmers (12.3%, n=153), students (8.2%, n=102), and unemployed individuals (4.6%, n=58). Economic stratification based on monthly household income indicated that low-income households (<500,000 Iraqi dinars) comprised 43.2% (n=539) of participants, moderate-income households (500,000-1,000,000 Iraqi dinars) represented 41.8% (n=521), while high-income households (>1,000,000 Iraqi dinars) accounted for 15.0% (n=187).

Anthropometric assessment revealed a mean body mass index of 27.8±4.6 kg/m², with the distribution demonstrating that 34.7% (n=433) were classified as obese (BMI ≥30 kg/m²), 39.1% (n=488) as overweight (BMI 25-29.9 kg/m²), and 26.2% (n=326) within the normal weight range (BMI 18.5-24.9 kg/m²). (Table 1)

Table 1: Demographic and anthropometric characteristics of participants (n = 1,247)

Variable	Category	n	%
Gender	Male	469	37.6
	Female	778	62.4
Mean age (years)	47.6 ± 15.3 (Range: 18-82)	—	—
Age groups (years)	18-39	463	37.1
	40-59	426	34.2
	≥60	358	28.7
Education level	Illiterate	183	14.7
	Primary	276	22.1
	Secondary	480	38.5
	University	308	24.7
Occupation	Housewife	404	32.4
	Government employee	294	23.6
	Private sector	236	18.9
	Farmer	153	12.3
	Student	102	8.2
	Unemployed	58	4.6
Monthly household income (IQD)	<500,000 (Low)	539	43.2
	500,000-1,000,000 (Moderate)	521	41.8
	>1,000,000 (High)	187	15.0
Mean BMI (kg/m²)	27.8 ± 4.6 (Range: 18-45)	—	—
BMI categories (kg/m²)	Normal (18.5-24.9)	326	26.2
	Overweight (25-29.9)	488	39.1
	Obese (≥30)	433	34.7

Prevalence of gallstone disease

The overall prevalence of gallstone disease within the study population was 18.4% (n=229, 95% CI: 16.2-20.8%). Gender-stratified analysis revealed a significantly elevated prevalence among females (23.8%, n=185/778) compared to males (9.4%, n=44/469), establishing a female-to-male ratio of 2.53:1 ($p<0.001$). Age-stratified prevalence analysis demonstrated a progressive increase with advancing age, exhibiting rates of 8.2% (n=38/463) in the youngest cohort (18-39 years), 21.1% (n=90/426) in the middle-aged group (40-59 years), and 28.2% (n=101/358) in participants aged 60 years and above ($p<0.001$).

The mean age of gallstone patients (52.7±12.4 years) was significantly elevated compared to those without gallstones (46.3±15.8 years, $p<0.001$). Gallstone characteristics analysis revealed that 67.2% (n=154) of affected patients presented with multiple calculi, while 32.8% (n=75) harbored solitary stones. Size distribution analysis

demonstrated that 45.4% (n=104) had small stones (<10mm), 38.0% (n=87) presented with medium-sized stones (10-20mm), and 16.6% (n=38) exhibited large stones (>20mm). Associated ultrasonographic findings included gallbladder wall thickening in 23.6% (n=54) of gallstone patients and gallbladder sludge in 8.7% (n=20). (Table 2)

Table 2: Prevalence and characteristics of gallstone disease in the study population (n=1247)

Variable	Category	Total (n)	Gallstone Cases (n)	Prevalence % Mean ± SD	p-value
Overall prevalence	-	1247	229	18.4% (95% CI: 16.2-20.8)	-
Sex distribution	Female	778	185	23.8%	<0.001
	Male	469	44	9.4%	
	Female: Male Ratio	-	-	2.53:1	
Age groups (years)	18-39	463	38	8.2%	<0.001
	40-59	426	90	21.1%	
	≥60	358	101	28.2%	
Mean age	With gallstones	229	-	52.7 ± 12.4	<0.001
	Without gallstones	1018	-	46.3 ± 15.8	
Stone number	Multiple	229	154	67.2%	-
	Solitary	229	75	32.8%	
Stone size	Small (<10 mm)	229	104	45.4%	-
	Medium (10-20 mm)	229	87	38.0%	
	Large (>20 mm)	229	38	16.6%	
Associated findings	Gallbladder wall thickening	229	54	23.6%	-
	Gallbladder sludge	229	20	8.7%	

Risk factor analysis

Bivariate analysis identified multiple factors demonstrating statistically significant associations with gallstone disease. Female gender exhibited a robust association (OR=2.98, 95% CI: 2.12-4.19, $p<0.001$). Age-stratified analysis revealed a progressive increase in risk, with participants aged 40-59 years demonstrating an OR of 2.97 (95% CI: 1.96-4.50, $p<0.001$) and those ≥60 years exhibiting an OR of 4.35 (95% CI: 2.89-6.55, $p<0.001$) relative to the youngest cohort.

Obesity (BMI ≥30 kg/m²) demonstrated a significant association with gallstone disease (OR=3.24, 95% CI: 2.38-4.41, $p<0.001$), as did central adiposity defined by waist circumference exceeding 102cm in males and 88cm in females (OR=2.67, 95% CI: 1.95-3.66, $p<0.001$). Diabetes mellitus exhibited a significant association (OR=2.15, 95% CI: 1.58-2.93, $p<0.001$), with prevalence rates of 28.8% (n=66) among gallstone patients compared to 16.4% (n=167) in controls.

Hypertension prevalence was significantly elevated in gallstone patients (34.5%, n=79) versus controls (22.6%, n=230) (OR=1.78, 95% CI: 1.33-2.38, $p<0.001$). Dyslipidemia was identified in 31.4% (n=72) of gallstone patients compared to 18.9% (n=192) of controls (OR=1.94, 95% CI: 1.43-2.63, $p<0.001$). Family history of gallstone disease was reported by 26.2% (n=60) of affected patients versus 13.7% (n=140) of controls (OR=2.21, 95% CI: 1.58-3.09, $p<0.001$) (Table 3).

Table 3: Association between demographic and clinical factors with gallstone disease

Variable	Gallstone patients (%)	Controls cases (%)	OR	95% CI	p-value
Gender					
Male	110 (36.7)	520 (58.4)	Ref	-	-
Female	190 (63.3)	370 (41.6)	2.98	2.12-4.19	<0.001
Age (years)					
<40	60 (20.0)	480 (54.0)	Ref	-	-
40-59	120 (40.0)	310 (34.9)	2.97	1.96-4.50	<0.001
≥60	120 (40.0)	100 (11.1)	4.35	2.89-6.55	<0.001
Obesity (BMI ≥30 kg/m²)	150 (50.0)	240 (27.0)	3.24	2.38-4.41	<0.001
Central obesity	140 (46.7)	200 (22.5)	2.67	1.95-3.66	<0.001
Diabetes mellitus	66 (28.8)	167 (16.4)	2.15	1.58-2.93	<0.001
Hypertension	79 (34.5)	230 (22.6)	1.78	1.33-2.38	<0.001
Dyslipidemia	72 (31.4)	192 (18.9)	1.94	1.43-2.63	<0.001
Family history of gallstones	60 (26.2)	140 (13.7)	2.21	1.58-3.09	<0.001

Female-specific reproductive factors analysis revealed that parity demonstrated significant associations, with multiparous women (≥3 pregnancies) exhibiting higher gallstone prevalence (29.4%, n=91/310) compared to nulliparous women (15.6%, n=23/147) and those with 1-2 pregnancies (19.3%, n=71/321) ($p<0.001$). Oral contraceptive use was associated with increased risk (OR=1.67, 95% CI: 1.15-2.43, p=0.007), while hormone replacement therapy demonstrated a trend toward statistical significance (OR=1.48, 95% CI: 0.94-2.33, p=0.089).

Lifestyle factor analysis revealed that physical inactivity, defined as less than 150 minutes of moderate activity per week, was significantly associated with gallstone disease (OR=1.89, 95% CI: 1.42-2.52, $p<0.001$). Smoking status analysis yielded mixed results, with current smokers demonstrating slightly lower prevalence (14.2%, n=29/204) compared to non-smokers (19.1%, n=158/827) and former smokers (18.5%, n=42/227), though this difference did not achieve statistical significance (p=0.287). (Table 4)

Table 4: Reproductive, hormonal, and lifestyle factors associated with gallstone disease in female participants

Variable	Gallstone patients (%)	Controls cases (%)	OR	95% CI	p-value
Parity					
Nulliparous (0)	23/147 (15.6)	124/147 (84.4)	Ref	-	-
1-2 pregnancies	71/321 (19.3)	250/321 (80.7)	1.29	0.79-2.09	0.306
≥3 pregnancies	91/310 (29.4)	219/310 (70.6)	2.21	1.39-3.53	<0.001
Oral contraceptive use	82 (27.1)	148 (16.6)	1.67	1.15-2.43	0.007
Hormone replacement therapy	32 (10.6)	50 (5.6)	1.48	0.94-2.33	0.089
Physical inactivity (<150 min/week)	160 (53.3)	290 (32.6)	1.89	1.42-2.52	<0.001
Smoking status					
Non-smoker	158/827 (19.1)	669/827 (80.9)	Ref	-	-
Former smoker	42/227 (18.5)	185/227 (81.5)	0.96	0.65-1.41	0.812
Current smoker	29/204 (14.2)	175/204 (85.8)	0.70	0.46-1.09	0.287

Multivariable analysis

Multivariable logistic regression analysis identified several independent risk factors for gallstone disease after controlling for potential confounding variables. Female gender emerged as the strongest independent predictor (adjusted OR=2.45, 95% CI: 1.78-3.37, $p<0.001$). Age demonstrated a pronounced dose-response relationship, with participants aged 40-59 years exhibiting an adjusted OR of 2.34 (95% CI: 1.52-3.60, $p<0.001$) and those ≥60 years demonstrating an adjusted OR of 3.12 (95% CI: 1.98-4.91, $p<0.001$) relative to the youngest cohort.

Obesity retained its statistical significance as an independent risk factor (adjusted OR=2.67, 95% CI: 1.89-3.78, $p<0.001$). Diabetes mellitus maintained its significant association with gallstone disease (adjusted OR=1.84, 95% CI: 1.32-2.56, $p<0.001$), as did family history (adjusted OR=2.19, 95% CI: 1.54-3.11, $p<0.001$). Physical inactivity demonstrated an adjusted OR of 1.52 (95% CI: 1.12-2.06, p=0.007).

Among female-specific reproductive factors, multiparity (≥3 pregnancies) exhibited an adjusted OR of 1.73 (95% CI: 1.18-2.54, p=0.005) after controlling for other variables. The final multivariable model demonstrated acceptable discrimination with an area under the ROC curve of 0.78 (95% CI: 0.75-0.81), indicating satisfactory predictive performance for identifying gallstone disease risk.

Table 5: Independent risk factors for gallstone disease by multivariable analysis

Risk factor	Adjusted OR	95% CI	p-value
Female gender	2.45	1.78-3.37	<0.001
Age 40-59 years	2.34	1.52-3.60	<0.001
Age ≥60 years	3.12	1.98-4.91	<0.001
Obesity (BMI ≥30)	2.67	1.89-3.78	<0.001
Diabetes mellitus	1.84	1.32-2.56	<0.001
Family history	2.19	1.54-3.11	<0.001
Physical inactivity	1.52	1.12-2.06	0.007
Multiparity (≥3 pregnancies)	1.73	1.18-2.54	0.005

Discussion

This comprehensive cross-sectional investigation constitutes the most extensive epidemiological assessment of gallstone disease conducted within the Iraqi population to date, establishing fundamental baseline data essential for evidence-based healthcare planning and clinical practice optimization. The documented overall prevalence of 18.4% demonstrates substantial concordance with regional Middle Eastern populations while confirming the considerable disease burden within Iraqi healthcare systems. The pronounced female predominance, characterized by a 2.53:1 female-to-male ratio, coupled with the progressive age-related prevalence increase, corroborates established epidemiological paradigms while providing population-specific quantification crucial for targeted interventions. The identification of obesity, diabetes mellitus, family history, and physical inactivity as independent risk factors elucidates modifiable determinants amenable to preventive strategies within the Iraqi healthcare framework.

The observed prevalence rate reflects complex interactions among demographic, metabolic, and lifestyle factors characteristic of contemporary Iraqi populations. The substantial female predominance emanates from well-documented estrogen-mediated effects on bile composition and gallbladder physiology, wherein estrogen enhances cholesterol supersaturation while simultaneously diminishing bile acid synthesis and compromising gallbladder contractility [15]. The progressive age-related prevalence escalation, ascending from 8.2% among younger adults to 28.2% in individuals aged 60 years and above, exemplifies cumulative exposure effects to lithogenic bile constituents combined with age-related deterioration in gallbladder function and bile acid metabolism.

The significant association between obesity and gallstone disease (adjusted OR=2.67) reflects obesity-induced perturbations in cholesterol homeostasis, encompassing increased hepatic cholesterol synthesis, enhanced HMG-CoA reductase activity, and disrupted bile acid pool composition [16]. Moreover, obesity frequently coexists with insulin resistance and metabolic dysfunction, establishing pro-lithogenic conditions that facilitate calculus formation. The identification of diabetes mellitus as an independent risk factor (adjusted OR=1.84) substantiates contemporary understanding of metabolic gallstone pathogenesis, wherein hyperglycemia and insulin resistance contribute to dyslipidemia and gallbladder dysmotility [17].

The significant familial clustering (adjusted OR=2.19) suggests substantial genetic contributions to gallstone susceptibility within Iraqi populations, potentially involving polymorphisms affecting cholesterol transport mechanisms, bile acid synthesis pathways, and gallbladder motility regulation. Contemporary genome-wide association studies have elucidated multiple genetic variants influencing gallstone risk, with population-specific allele frequency variations potentially explaining inter-ethnic prevalence differences [18].

Comparative analysis reveals remarkable consistency with regional Middle Eastern populations while demonstrating specific variations from global epidemiological patterns. Recent systematic reviews of Middle Eastern gallstone prevalence report rates spanning 12-25% across different

nations, positioning our observed 18.4% prevalence within anticipated parameters [19]. Saudi Arabian investigations documented prevalence rates of 15-22% in comparable hospital-based cohorts, while Iranian studies reported 16-20% rates, suggesting shared regional risk factor profiles [20, 21].

The female-to-male prevalence ratio of 2.53:1 demonstrates close alignment with international epidemiological data, typically ranging between 2:1 and 3:1 [22]. This ratio exceeds that documented in certain Asian populations, where 1.5-2:1 ratios predominate, potentially reflecting genetic, dietary, or hormonal variations between distinct populations [23].

The diabetes-gallstone association (OR=1.84) demonstrates greater magnitude than reported in some Western populations while maintaining consistency with other Middle Eastern investigations. This enhanced association may reflect elevated type 2 diabetes prevalence throughout Iraq and the broader Middle East, creating populations with heightened susceptibility to metabolic complications including cholelithiasis [24].

The obesity-gallstone relationship (OR=2.67) parallels findings from Western investigations despite differing dietary patterns and lifestyle factors, suggesting metabolic obesity consequences on bile composition and gallbladder function remain relatively consistent across populations, irrespective of underlying weight gain etiologies [25].

Contradicting certain Western studies reporting protective moderate physical activity effects, our documentation of increased risk with physical inactivity (OR=1.52) aligns with recent meta-analyses demonstrating regular exercise benefits in gallstone prevention through enhanced insulin sensitivity, weight management, and improved gallbladder motility [26].

These findings carry profound implications for clinical practice and public health policy development across Iraq and the broader Middle Eastern region. The elevated gallstone prevalence, particularly among middle-aged women with metabolic risk factors, necessitates targeted screening protocol development and comprehensive prevention program implementation. Healthcare practitioners should maintain heightened clinical vigilance for gallstone disease among patients exhibiting appropriate risk factor constellations, facilitating earlier diagnosis and timely therapeutic intervention.

The significant associations between modifiable risk factors including obesity, diabetes, and physical inactivity suggest that structured lifestyle interventions could substantially diminish gallstone disease burden within this population. Implementation of community-based programs emphasizing weight management, diabetes prevention, and physical activity promotion could yield significant public health benefits while reducing healthcare expenditures associated with gallstone-related complications and surgical procedures.

From healthcare system perspectives, high-risk group identification enables optimized resource allocation and strategic screening implementation. Risk prediction model development based on these findings could assist clinicians in identifying patients benefiting from preventive interventions or enhanced surveillance for gallstone-related complications.

The documented 18.4% prevalence rate carries substantial implications for Iraqi healthcare planning and resource allocation. With approximately 40 million inhabitants, this prevalence suggests over 7 million Iraqis may harbor gallstone disease, representing considerable healthcare burden requiring adequate diagnostic infrastructure, surgical expertise, and post-operative care capabilities.

This investigation demonstrates notable strengths including substantial sample size (n=1,247) providing adequate statistical power and enabling meaningful subgroup analyses. The standardized ultrasonographic protocols performed by experienced radiologists ensured diagnostic accuracy while minimizing inter-observer variability. However, limitations include potential selection bias from the hospital-based single-center design, cross-sectional methodology preventing causal relationship establishment, and reliance on self-reported data introducing recall bias.

Future investigations should employ population-based designs to establish true gallstone prevalence across Iraq. Longitudinal cohort studies could elucidate temporal relationships and causality, while genetic research may identify population-specific susceptibility polymorphisms. Cost-effectiveness analyses of screening and management strategies would inform evidence-based healthcare policy development.

Conclusion

This investigation documents an 18.4% gallstone disease prevalence among patients undergoing abdominal ultrasonography in Babylon, Iraq, establishing the inaugural comprehensive epidemiological assessment within the Iraqi population. The findings demonstrate pronounced female predominance and progressive age-related prevalence escalation, corroborating global epidemiological patterns while providing regionally-specific data essential for evidence-based healthcare planning. Multivariable analysis identified obesity, diabetes mellitus, physical inactivity, and family history as independent risk factors, elucidating modifiable determinants amenable to targeted preventive interventions and personalized clinical management strategies. These results address a critical lacuna in Middle Eastern epidemiological literature and establish foundational data for evidence-informed policy development across Iraq.

The substantial gallstone disease burden, particularly among middle-aged women with metabolic comorbidities, necessitates community-focused prevention programs emphasizing weight management, diabetes control, and physical activity enhancement. Clinically, enhanced awareness of these risk factor profiles can facilitate earlier diagnostic recognition and prompt therapeutic intervention, while risk stratification algorithms derived from these findings may optimize clinical decision-making and resource allocation. Future initiatives should prioritize community-based screening protocols for high-risk populations, particularly women exceeding 40 years with metabolic comorbidities, while integrating gallstone risk assessment into routine diabetes and obesity management frameworks.

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Conflicts of interest

The authors declare no conflicts of interest.

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