

Investigating the Prevalence and Risk Factors of Gallstone Disease in Al Jouf region, the Kingdom of Saudi Arabia.

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ABSTRACT

Background: Gallstone disease, referred to as cholelithiasis, constitutes a widespread surgical disorder marked by the formation of calculi within the gallbladder or bile ducts. Patients may remain asymptomatic until incidentally detected through imaging studies. However, when a stone obstructs the bile ducts or triggers inflammation cholecystitis, symptoms such as upper abdominal discomfort and jaundice manifest. Cholelithiasis has consistently posed a global health burden. Numerous predisposing factors have been delineated, encompassing female gender, obesity, rapid weight reduction, familial history, and diabetes mellitus. In this study our principal objective is to ascertain the prevalence of cholelithiasis within the Al Jouf region. Additionally, the study seeks to determine the risk factors that give rise to cholelithiasis in this demographic and to elucidate the relationship between these risk factors and the occurrence of cholelithiasis.

Methods: A cross-sectional study was conducted among 582 participants in the Al Jouf region, Kingdom of Saudi Arabia. A self-administrated online questionnaire was used as the data collection tool; it consisted of multiple-choice questions. IBM SPSS Statistics version 25 IBM Corp., Armonk, NY was used to analyze the collected data.

Results: Our results have revealed a noteworthy prevalence of 48.79% for gallstone disease within the studied population, thereby establishing gallstone disease GD as a prominent health concern within this demographic. A heightened prevalence of symptoms was observed among respondents aged 45 years or older 38.2%, those classified as overweight 28.9% or obese 33.3%, housekeepers 43.1%, and those who are divorced 30%. Evidently, a group of factors demonstrates a positive correlation with gallstone disease in the Al Jouf region. These factors include age, employment status, familial predisposition to gallstone disease, concurrent medical conditions, usage of hormonal contraceptives among women, and a history of bariatric surgery. The outcomes of this study are poised to provide a fundamental groundwork for the implementation of evidence-based clinical practices and public health interventions. Ultimately, these findings offer a valuable insight into the current situation of gallstone disease, revealing how widespread the disease is and the risk factors linked to it in the Al Jouf region.

Conclusion: Our study revealed a gallstone disease prevalence of approximately 48.79% within our sample, with a higher incidence observed among females. Notably, a considerable proportion of cases exhibited absence of medical comorbidities and abstention from tobacco, alcohol, high-fat diet, and coffee consumption. The influence of a history of bariatric surgery emerged as a noteworthy factor in gallstone disease development.

Key Words: Prevalence , Risk, Factors, Gallstone Disease

INTRODUCTION

Gallstone disease GSD is a global health concern and a prevalent reason for surgical interventions, contributing to considerable health care costs. However, its prevalence varies widely among different populations¹. Gallstones are the most common risk factor for admission to emergency room that impose a significant worldwide health issue and economic burden². Gallstones pose a substantial concern within numerous nations, Saudi Arabia included^{3,4}. As the prevalence of gallstones continues to rise, cholecystectomy has ascended to become one of the foremost frequently performed abdominal surgery within Saudi Arabia⁵. Several risk factors have been linked to gallstone

disease, including female gender⁶; alongside a range of risk factors including aging, obesity, multiple pregnancies, sedentary lifestyle, high energy intake, family history of cholelithiasis, and cholecystitis^{7,8,9}. Additionally, gallstones exhibit a higher occurrence in individuals with specific conditions, such as Cron's disease and liver cirrhosis¹⁰. Despite these insights, a significant research gap remains, particularly in understanding the prevalence and associated risk factors of gallstone disease in the Al Jouf region. Our study aims to address this gap by achieving the following objectives: 1 Assessing the prevalence of gallstone disease in Al Jouf region, 2 Identifying demographic and clinical risk factors associated with gallstone disease in this area, and

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3 Investigating the potential relationship between lifestyle factors, including diet and physical activity, and the incidence of gallstone disease in Al Jouf region.

METHODOLOGY

We executed a cross-sectional study to investigate both the prevalence and evaluate the risk factors associated with gallstone disease among the adult population in Al Jouf, Kingdom of Saudi Arabia KSA. A convenience sampling approach was employed.

With a confidence level of 95% with a 5% margin of error, our calculated sample size was 383. However, we successfully gathered data from 582 individuals. The sampling approach adhered to the 2019 report from the General Authority for Statistics GAS of the Kingdom of Saudi Arabia, which indicated a population count of 531,952 11. We gathered data using a self-administered questionnaire designed by Google Docs and distributed via various online platforms. The questionnaire contained multiple-choice questions. The initial part of the questionnaire was an inquiry into the participants sociodemographic status, encompassing variables such as age, gender, body mass index BMI, educational level, employment status, marital status, place of residence, and income. Subsequently, the second section was dedicated to an evaluation of gallstone disease prevalence within the study population, while the third section concentrated on assessing risk factors associated with the gallstone disease. It is important to note that the questionnaire employed in this study was not subjected to formal validation procedures. While every effort was made to design a comprehensive and relevant questionnaire.

Inclusion criteria: participants who are more than 18 years old and less than 80 years old living in Al Jouf region.

Exclusion criteria: incomplete forms, individuals who are unwilling to participate.

This research study did not require ethical approval as confirmed by [email of Ethical Committee chairman /Institutional Review Board] dated at 13/12/2024. The study involved [general individuals/general public] and did not involve accessing medical records, patients, or any sensitive or identifiable personal data. All participants were informed about the study's purpose, and consent was obtained where applicable with this: Ethical Approval Statement

It is important to highlight that the questionnaire was not containing any personally identifiable data. The statistical analysis was performed using IBM SPSS Statistics version 25 IBM Corp., Armonk, NY. A descriptive data analysis was conducted to examine the characteristics of the participants.

RESULTS

In this study, a mass screening of 582 individuals was carried out in Al Jouf region, Sakakah, Saudi Arabia. The main objective was to investigate the prevalence of gallstones disease and to identify its associated risk factors. Importantly, all participants, voluntarily, consented to participate in the study and provided their informed consent.

First, a descriptive data analysis was conducted to examine the characteristics of the participants, both for socio-demographic characteristics and potential risk factors. Next, the presence of gallstone risk factors was cross tabulated against the occurrence of gallstone disease symptoms using the Chi-square test. The χ^2 probability was utilized to determine the significance of these relationships with a

significance level of 0.05. Finally, a binomial multivariate logistic regression was performed to explore the demographic, clinical and lifestyle determinants associated with the manifestation of gallstone disease symptoms.

Characteristics of the study participants:

Table 1. describes the socio-demographic characteristics of the study participants. Out of the total 582 participants, 444 76.3% were females. Approximately 48.8% of the participants, which accounts for 284 individuals, fell within the age group of 18-25 years. A significant proportion of the study participants were unemployed 42%, n=318 and unmarried 50.7%, n=295, with the majority of them pursuing their high school diploma and bachelor's degree 93%, n=541. Nearly two-thirds of the participants resided in Sakakah 63.7%, n=371. The monthly average income for the majority of participants was less than 2500 Saudi Riyal 48.1%, n=280. Regarding the Body Mass Index BMI measurements, more than half of the participants fell within the healthy weight range 54.3%, n=316. However, a considerable number was in the overweight range, comprising just under a quarter of the participants 24.4%, n=142. Relatively fewer individuals were classified as obese 17.5%, n=102.

Table 1. Characteristics of participants (n= 582)

Variables	Total: n %
Gender	
Male	138 23.7
Female	444 76.3
Age	
18-25	284 48.8
26-35	82 14.1
36-45	80 13.7
>45	136 23.4
Body Mass Index BMI	
Under-weight >18.5	22 3.8
Normal Weight 18.5-24.9	316 54.3
Over-weight 25-29.9	142 24.4
Obese > 30	102 17.5
Education Level	
Less than a high school diploma	16 2.7
High school diploma	152 26.2
Bachelor's	389 66.8
Postgraduate	25 4.3
Residence	
Dumat Al Jandal	29 5.0
Qurayyat	149 25.6
Sakakah	371 63.7
Tabarjal	2 0.4
Other	31 5.3
Employment Status	
Housekeeper	51 8.8
Unemployed	318 54.6
Employed	173 29.7
Retired	40 6.9
Marital Status	
Single	295 50.7
Married	277 47.6
Divorced	10 1.7
Income	
<2500	280 48.1

2500-5000	64 11.0
5000-1000	80 13.7
10000-20000	122 21.0
>20000	36 6.2

n: number, %: percentage

Prevalence of gallstones disease determinant factors:

As shown in Table 2., more than half of the participants 52.2%, n=305 had a positive family history of gallstone disease. Additionally, a significant majority of the participants 70.4%, n=410 did not report any co-existing medical conditions. Out of the participants who reported having associated medical illnesses n=172, 29.6%, the prevalence of Obesity was present in 12.5%, Diabetes mellitus in 11.5%, Hypertension in 5.2%, and Liver disease in 0.3% of the respondents. A large majority of the participants were non-smokers 91.4%, abstained from alcohol consumption 99.1%, and used caffeine to varying degrees 78.2%. Most participants also avoided consuming a high-fat diet 87.1%. However, only a relatively small percentage of them engaged in regular physical exercise 19.8%. Additionally, a minority of the respondents reported having undergone previous bariatric surgery 5%. Among female participants, only 32.6% had given birth at least twice, while merely 7% used hormonal contraceptives.

Table 2. Descriptive Statistics of Risk Factors For Gallstone Disease (n= 582)

Variables	Total: n %
Have any of your family members been diagnosed with gallstone disease?	
Yes	305 52.2
No	227 47.6
Do you have any of the following medical conditions?	
Diabetes Miletus	67 11.5
Hypertension	30 5.2
Liver disease	2 0.3
Obesity	73 12.5
None	410 70.4
Do you smoke?	
Yes	50 8.6
No	532 91.4
Do you consume alcohol?	
Yes	5 0.9
No	577 99.1
Do you consume a high-fat diet?	
Yes	75 12.9
No	507 87.1
Do you perform physical exercises on a regular basis?	
Yes	115 19.8
No	467 80.2
Do you use hormonal contraceptives?	
Yes	41 7.0
No	345 59.3
Not applicable	196 33.7
Have you ever had bariatric surgery?	
Yes	29 5.0
No	553 95.0
Number of pregnancies?	
I did not give birth	241 41.4
Twice	36 6.2

3 times	28 4.8
More than 3 times	126 21.6
Not applicable	151 25.9

Coffee intake?

I do not drink coffee all the time	127 21.8
1 cup	122 21.0
2 cups	135 23.2
3 cups	80 13.7
More than 3 cups	118 20.3

n: number, %: percentage

In this study, we sought to determine the overall prevalence of gallstone disease in a sample of 582 participants. To achieve this, we utilized three specific questions to assess the presence of gallstone disease among the respondents:

1. "Have you ever been diagnosed with gallstone disease?"
2. "Have you undergone any surgical procedures or received medical treatment for gallstone disease?"
3. "Have you experienced any symptoms of gallstone disease, such as abdominal pain, nausea, or vomiting?"

As shown in Table 3., out of the total 582 participants, 284 individuals answered "YES" to all the three questions, indicating a positive indication of gallstone disease. To calculate the overall prevalence of gallstone disease, we applied the following formula:

Overall Prevalence = Number of individuals who answered "YES" to at least one question / Total number of respondents * 100

By inserting the relevant values: Overall Prevalence = 284 / 582 * 100 ≈ 48.79%

Consequently, the overall prevalence of gallstone disease in the sample was found to be approximately 48.79%. This finding underscores the significance of gallstone disease as a prevalent health issue within the studied population.

Table 3. Prevalence of Gallstone Disease among Participants

Questions of gallstone disease	Yes n %	No n %
Have you experienced any symptoms of gallstone disease, such as abdominal pain, nausea, or vomiting?		
Have you ever been diagnosed with gallstone disease?	80 13.7	502 86.3
Have you undergone any surgical procedures or received medical treatment for gallstone disease?	69 11.9	513 88.1

n: number, %: percentage

Risk factors associated with gallstone disease symptomatology:

As illustrated in Table.4, respondents aged above 45 years had the highest prevalence of experiencing symptoms of gallstones 38.2%, which was statistically significant compared to other age groups p-value< 0.05. Participants who were overweight and obese showed higher prevalence rates of symptoms, accounting for 28.9% and 33.3%, respectively p-value< 0.05. Notably, housekeepers had the highest prevalence of gallstones 43.1%, likely due to their sedentary lifestyle. Divorced individuals were more susceptible to the disease 30% compared to married and single individuals p-value< 0.05. Furthermore, respondents with the highest income >20,000 SR monthly were the most vulnerable to gallstones, with a prevalence of 33.3%, compared

to others with lower salaries $p\text{-value} < 0.05$. Also, individuals with a positive family history of gallstones 32.5% and those with co-existing chronic medical conditions like Diabetes 41.8% and Obesity 24.7% had a lower prevalence of the disease compared to others $p\text{-value} < 0.05$. Additionally, women who used hormonal contraceptives and/or had given birth more than three times were at a higher risk, with percents of 46.3% and 41.3%, respectively $p\text{-value} < 0.05$. Lastly, participants who had undergone previous bariatric surgery 44.8% were nearly 2 times more likely to develop gallstones compared to those who did not $p\text{-value} < 0.05$. Conversely, there were no statistically significant differences observed among sub-categories of gender, education levels, city of residence, smoking, alcohol consumption, high-fat diet consumption, physical exercise, and caffeine intake in relation to the prevalence of gallstone symptomatology.

Table 4. Prevalence of risk factors among participants who experienced gallstone disease symptomatology (n = 582)

Variables	Cases who had symptoms of gallstones n %		p-value
	Yes	No	
Gender			
Male	26 18.8	112 81.2	0.204
Female	109 24.5	335 75.5	
Age			
18-25	41 14.4	243 85.6	0.001
26-35	18 22.0	64 78.0	
36-45	24 30.0	56 70.0	
>45	52 38.2	84 61.8	
Body Mass Index BMI			
Under-weight	5 22.7	17 77.3	0.001
Normal weight	55 17.4	261 82.6	
Over-weight	41 28.9	101 71.1	
Obese	34 33.3	68 66.7	
Education Level			
Less than a high school diploma	6 37.5	10 62.5	0.095
High school diploma	26 17.1	126 82.9	
Bachelor's	95 24.4	294 75.6	
Postgraduate	8 32.0	17 68.0	
Residence			
Dumat Al Jandal	5 17.2	24 82.8	0.176
Qurayyat	26 17.4	123 82.6	
Sakakah	94 25.3	277 74.7	
Tabarjal	0 0.0	2 100.0	
Other	10 32.3	21 67.7	
Employment Status			
Housekeeper	22 43.1	29 56.9	0.001
Unemployed	52 16.4	226 83.6	
Employed	52 30.1	121 69.9	
Retired	9 22.5	31 77.5	
Marital Status			
Single	51 17.3	244 82.7	0.001
Married	81 29.2	196 70.8	
Divorced	3 30.0	7 70.0	
Income			

<2500	49 17.5	231 82.5	
2500-5000	15 23.4	49 76.6	
5000-1000	23 28.7	57 71.3	0.023
10000-20000	36 29.5	86 70.5	
>20000	12 33.3	24 66.7	
Have any of your family members been diagnosed with gallstone disease?			
Yes	99 32.5	206 67.5	0.001
No	36 13.0	241 87.0	
Do you have any of the following medical conditions?			
Diabetes Miletus	28 41.8	39 58.2	0.001
Hypertension	8 26.7	22 73.3	
Liver disease	1 50.0	1 50.0	
Obesity	18 24.7	55 75.3	
None	80 19.5	330 80.5	
Do you smoke?			
Yes	11 22.0	39 78.0	0.497
No	124 23.3	408 76.7	
Do you consume alcohol?			
Yes	0 0.0	5 100.0	0.266
No	135 23.4	442 76.6	
Do you consume a high-fat diet?			
Yes	22 29.3	53 70.7	0.116
No	113 22.3	394 77.7	
Do you perform physical exercises on a regular basis?			
Yes	20 17.4	95 82.6	0.110
No	115 24.6	352 75.4	
Do you use hormonal contraceptives?			
Yes	19 46.3	22 53.7	0.001
No	81 23.5	264 76.5	
Not applicable	35 17.9	161 82.1	
Have you ever had bariatric surgery?			
Yes	13 44.8	16 55.2	0.011
No	122 22.1	431 77.9	
Number of pregnancies?			
I did not give birth	38 15.8	203 84.2	0.001
Twice	7 19.4	29 80.6	
3 times	8 28.6	20 71.4	
More than 3 times	52 41.3	74 58.7	
Not applicable	30 19.9	121 80.1	
Coffee intake?			
I do not drink coffee all the time	29 22.8	98 77.2	0.489
1 cup	23 18.9	99 81.1	
2 cups	29 21.5	106 78.5	
3 cups	21 26.2	59 73.8	
More than 3 cups	33 28	85 72.0	
Total	135 23.2	477 76.8	

n: number, %: percentage

Based on the findings presented in Table 5, the binomial logistic regression analysis identified several factors positively associated with gallstones. These factors encompass respondents' age, employment status, family history of gallstone disease, presence of associated medical conditions, use of hormonal contraceptives for women, and history of bariatric surgery. The results highlighted that:

Table 5. Logistic regression analysis of the risk factors affecting gallstones (n=582)

Variables n %	Levels	Wald χ^2	OR 95% CI	p-value
Gender M= ref	Female	0.003	1.025 0.425-2.470	0.966
Age <45= ref	>45	6.665	2.706 1.271-5.762	0.010
Body Mass Index BMI Obesity= ref	Over-weight	0.581	1.292 0.669-2.497	0.446
Education level Bachelor's= ref	Secondary school	2.123	0.659 0.376-1.155	0.145
Residence Tabarjal= ref	Sakakah	0.000	0.000	0.999
Employment status Unemployed= ref	Retired	5.266	0.247 0.075-0.816	0.022
Marital status M= ref	Married	0.731	0.506 0.106-2.409	0.392
Income >20.000= ref	10.000-20.000	0.179	0.812 0.309-2.131	0.672
Family history of gallstone disease ref	Yes	21.488	3.011 1.889-4.800	0.001
Presence of Co-existing medical conditions	Yes	4.535	0.802 0.655-0.983	0.033
Smoking	Yes	0.007	1.042 0.408-2.660	0.931
Drinking alcohol	Yes	0.000	0.000 0.000	0.999
Consumption of high-fat diet	Yes	2.473	1.688 0.879-3.242	0.116
Performing physical exercises on regular basis	Yes	1.184	0.716 0.392-1.307	0.277
Use of hormonal contraceptives females	Yes	5.742	1.774 1.110-2.836	0.017
Previous bariatric surgery	Yes	5.442	2.935 1.188-7.254	0.020
Previous pregnancies females	Yes	0.590	1.037 0.773-1.391	0.808
Coffee intake	Yes	0.044	0.984 0.846-1.145	0.838

1. Participants aged over 45 had 2.7 times higher odds of developing gallstone disease compared to younger ages Odds Ratio - OR: 2.7, 95% CI: 1.2–5.7.

2. Retired individuals exhibited 20% lower odds of experiencing gallstones compared to active workers, either housekeepers, students, or employees OR: 0.2, 95% CI: 0.07–0.81.

3. The presence of other medical illnesses did not increase vulnerability to gallstones; instead, it was associated with approximately 40% lower odds of developing gallstones OR: 0.8, 95% CI: 0.6–0.9.

4. Among women, the use of hormonal contraceptives increased the susceptibility to gallstones by 1.7 times compared to non-users OR: 1.7, 95% CI: 1.1–2.8.

5. Finally, individuals who had previously undergone bariatric surgery showed a 2.9 times higher likelihood of developing gallstones compared to others who did not.

In contrast, variables such as sex, Body Mass Index BMI, education level, area of residence, marital status, monthly income, consumption of tobacco, alcohol, high-fat diet, coffee, physical inactivity, and the number of previous pregnancies did not influence the occurrence of gallstone disease.

DISCUSSION

Gallstone disease constitutes a significant global health burden, affecting millions of individuals worldwide. Globally, its prevalence varies, with a higher incidence observed in developed countries. It is estimated that approximately 10-15% of adults in Western populations experience gallstones, making it a prevalent and clinically relevant condition ¹². In the context of Saudi Arabia, gallstone disease is also of concern, recent research has highlighted the increasing prevalence of gallstones in the Saudi population, prompting the need for comprehensive studies to evaluate risk factors, pathogenesis, and preventative strategies ¹³.

Our study findings reveal a statistically significant association between age and the risk of gallstone disease. Participants aged over 45 exhibited 2.7 times higher odds of developing gallstones in comparison to younger participants. This aligns with prior research conducted in Riyadh ¹⁴, which reported a similar trend of increased gallstone risk with advancing age. These consistent observations indicate that age is a key risk factor for gallstone disease in Saudi Arabia and emphasize the importance of age-targeted preventive measures.

Recent research ¹⁵ mirrors our findings by showing no clear correlation between physical activity and the development of gallstones, a viewpoint shared by our study. In contrast, alternate studies ^{16,17} suggest that decreased physical activity might contribute to an increased risk of gallstones.

Our research outcomes highlight that those who use hormonal contraceptives face a 1.7 times higher chance of developing gallstones compared to non-users. This finding adds an intriguing layer to our understanding of gallstone risk factors for women. Interestingly, a similar conclusion was found in a study by ¹⁸⁻¹⁹, where they also observed an increased risk among hormonal contraceptive users. This shared result reinforces the credibility of our findings and points to a potential connection between hormonal contraceptives and gallstone susceptibility.

An insightful retrospective cohort study of all obese patients who underwent bariatric surgery in Riyadh, Saudi Arabia, revealed a significant association between weight loss post-surgery and the occurrence of cholelithiasis, with an incidence rate of 6.53% ¹⁹. Our findings matches these results, as we too identified a parallel association. Specifically, our study indicates that individuals with a history of bariatric surgery face a 2.9-fold increased probability of developing gallstones in comparison to those without such a surgical history.

Gallstone symptoms were prevalent in overweight individuals 28.9%, and obese individuals had an even higher prevalence 33.3%. In addition they were also prevalent in chronic medical conditions like Diabetes 41.8% which cloud indicates they might be not diagnosed yet.

Gallstone symptoms emerged more noticeably among those with excess weight, with a prevalence of 28.9% in overweight individuals and a higher 33.3% prevalence in the obese. This highlight the possibility that gallstone-related symptoms might serve as potential markers for the undiagnosed conditions of excess weight. This finding aligns with previous study²⁰, which observed a similar pattern of elevated gallstone symptoms among individuals with excess weight. Furthermore, these symptoms appeared to be increased with underlying chronic medical conditions such as Diabetes, where a 41.8% prevalence was noted.

Occupation-related sedentariness demonstrated an increased association with gallstone risk. Our study highlights that the unemployed and housekeepers have the high prevalence of gallstone symptoms 43.1%. This pattern can be attributed to their predominantly sedentary lifestyle, which has been previously linked to gallstone development. This observation is with aligns to²¹, in which they found that Unemployed and housekeepers were 4 times more likely to have gallstone disease compared to other job categories.

Within our findings, individuals who had experienced divorce emerged with a notable increase in symptom prevalence 30%, compared to the rates observed in both married and single participants. This notable difference receives support from an earlier investigation²², where researchers concluded that the risk of gallstone formation was threefold higher in divorced patients compared to those who were married OR = 2.99: 95% CI 1.02–9.16.

The intriguing interplay between income and gallstone symptoms emerged as yet another facet. Participants with the highest income >20,000 SR monthly demonstrated the highest prevalence of symptoms at 33.3%, in contrast to those with lower incomes. This aligns with²³, they had indicated a higher prevalence rate in middle-to-high income class, may have been due to the Westernized lifestyle of their patients.

While our study establishes a strong correlation between certain socio-demographic factors and gallstone symptoms, it's noteworthy that no statistically significant differences were observed among various sub-categories such as gender, education levels, city of residence, smoking, alcohol consumption, high-fat diet consumption, physical exercise, and caffeine intake.

It is important to acknowledge some limitations of the study. Firstly, the sample size of 582 individuals may not be representative of the entire population of the Al Jouf region, limiting the generalizability of the findings. Additionally, the study design was cross-sectional, which prevents the establishment of causal relationships between the identified risk factors and gallstone disease. Future research should consider larger sample sizes and prospective study designs to validate and expand upon these findings.

The absence of validation may pose a limitation in the assessment of its reliability and validity. Future studies could benefit from a more rigorous validation process to enhance reliability.

CONCLUSION

In sum, our study uncovers intriguing insights. We found that about 48.79% of our participants had gallstone disease, with a

higher occurrence in females. It's worth noting that many cases had no major health issues and didn't engage in habits like tobacco, alcohol, high-fat diets, or coffee consumption. Bariatric surgery history emerged as an important factor in gallstone development. While high BMI and pregnancy seemed connected, the link was not very strong. This study adds brushstrokes to our understanding of gallstone disease and suggests areas for further investigation. The results of this study can guide healthcare professionals in implementing targeted interventions and preventive measures to mitigate the impact of gallstone disease in the population.

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