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Association Between Gallbladder Surgery and Congestive Heart Failure: A Population-Based Cross-Sectional Analysis Using NHANES Data

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Introduction

Gallbladder disease is increasingly prevalent worldwide and often necessitates surgical intervention, most commonly cholecystectomy. While typically associated with gastrointestinal symptoms, gallbladder disease may reflect broader systemic inflammation and metabolic dysfunction. Given the shared risk factors between gallbladder disease and congestive heart failure (CHF), this study investigates whether a history of gallbladder surgery, used as a proxy for gallbladder disease is associated with a higher prevalence of CHF.

Methods

We conducted a cross-sectional analysis using data from the National Health and Nutrition Examination Survey (NHANES). Adults aged ⩾20 years with complete data on gallbladder surgery history and CHF diagnosis were included. Gallbladder surgery, assessed via self-report, was used as a proxy for gallbladder disease. CHF was determined through self-reported provider diagnosis. A multivariable logistic regression model was used to evaluate the association, adjusting for age, gender, race/ethnicity, education level, and marital status.

Results

Among 7,800 participants, 926 (11.9%) reported a history of gallbladder surgery. Those with gallbladder surgery were older and more likely to be female. In the adjusted model, gallbladder surgery was significantly associated with increased odds of CHF (OR = 1.90, 95% CI: 1.45–2.50, $p < 0.001$). Other significant predictors of CHF included older age, male gender, not being married, and lower educational attainment. Race and ethnicity were not significantly associated with CHF after adjustment.

Conclusion

A history of gallbladder surgery is significantly associated with increased odds of CHF, suggesting that gallbladder disease may serve as an early marker of cardiovascular risk. This association may be explained by shared underlying metabolic pathways or the direct metabolic consequences of cholecystectomy. These findings underscore the importance of cardiovascular risk assessment in patients with gallbladder pathology and support further research into shared biological mechanisms linking gallbladder and cardiovascular diseases.

INTRODUCTION

Gallbladder disease has increased prevalence and a significant impact on morbidity and health care utilization in the United States and worldwide. Gallbladder disease encompasses a range of conditions, the most prevalent of these are gallstones, also known as cholelithiasis. Another common condition is cholecystitis, an inflammation of the gallbladder that can manifest acutely or chronically. Gallbladder disease often leads to surgical intervention, commonly cholecystectomy-the removal of the gallbladder. Over the past 30 years, the prevalence of symptomatic cholelithiasis

has doubled in the United States, with more than 20 million people having ultrasound-detected gallbladder disease.[1,2] The increasing burden highlights the clinical relevance of gallbladder disease and raises important questions about its broader physiological impact beyond the gastrointestinal system. While gallbladder disease is typically associated with gastrointestinal symptoms and metabolic risk factors such as obesity and insulin resistance, gallbladder pathology may also reflect broader systemic inflammation and metabolic dysfunction.[3]

Given the metabolic and inflammatory components of gallbladder disease, it is important to consider its potential connections to other systemic conditions such as congestive heart failure (CHF). CHF is characterized by the heart's reduced ability to pump blood effectively, often resulting from or compounded by chronic comorbidities including hypertension, diabetes, and obesity.[4] Additionally, congestive heart failure remains a major public health concern, particularly among aging adults. As of 2017, there are an estimated 64.3 million people with CHF worldwide, classifying it as a global pandemic.[5] Based on the metabolic overlap and the chronic inflammatory burden observed in both gallbladder disease and CHF, individuals who undergo gallbladder surgery due to gallbladder disease may be at greater risk for cardiovascular complications.[6,7]

Although several studies have explored the association between gallstones and cardiovascular disease, research has primarily focused on this aspect rather than examining the broader spectrum of gallbladder disease or its relationship with CHF.[8] To address this gap, our study uses a history of gallbladder surgery as a proxy for gallbladder disease to investigate whether such a history is associated with a higher prevalence of CHF.

METHODS

We conducted a cross-sectional analysis using publicly available data from the National Health and Nutrition Examination Survey (NHANES). We included adult participants (≥20 years) with complete data on gallbladder surgery history and congestive heart failure diagnosis. Gallbladder surgery was assessed through the question, "Have you ever had gallbladder surgery?" While this variable captures surgical history rather than diagnosis, it was used as a proxy for gallbladder disease, under the assumption that most cholecystectomies are performed for symptomatic or chronic gallbladder pathology.

The primary outcome was self-reported CHF, based on participants' responses to whether a healthcare provider had ever diagnosed them with the condition. Covariates included age (continuous), gender, race/ethnicity (categorized as Black, Hispanic, and White), educational attainment (categorized as <9th grade, 9–11th grade, high school graduate/GED, some college/associate degree, and college graduate or above), and marital status (married vs. not married).

We performed a multivariable logistic regression to assess the association between gallbladder surgery and CHF while adjusting for all covariates. Statistical significance was set at $p < 0.05$, and all analyses were conducted in R.

RESULTS

A total of 7,800 participants had data regarding gallbladder surgery status, of whom 926 (11.9%) reported having undergone gallbladder surgery and 6,874 (88.1%) reported not having had the procedure (Table 1). Participants with a history of gallbladder surgery were older on average (60.70 ± 14.99 years) than those without (52.66 ± 17.63 years). Women made up a larger proportion of those who underwent gallbladder surgery (75.3%) compared to those who did not (52.6%)

White participants were the most represented racial group in both categories, but particularly among those who had gallbladder surgery (72.1% vs. 65.5%). Educational attainment also differed: a higher proportion of individuals with gallbladder surgery had completed some college or an associate degree (35.8% vs. 29.7%), while fewer held a college degree or higher (23.5% vs. 35.1%). Marital status was similar between groups, with just over half of participants in both categories being married (52.2% in the surgery group vs. 53.3% in the non-surgery group).

In a multivariable logistic regression model adjusting for age, gender, race, education, and marital status, gallbladder surgery was significantly associated with increased odds of congestive heart failure (CHF) (OR = 1.90, 95% CI: 1.45–2.50, $p < 0.001$; Table 2). Other significant predictors of CHF included older age (OR = 1.07 per year, $p < 0.001$), male gender (OR = 0.60, $p < 0.001$), not being married (OR = 1.44, $p = 0.003$), and lower educational attainment. Individuals with a college degree or higher were significantly less likely to have CHF compared to those with less than a 9th-grade education (OR = 0.31, $p < 0.001$). Race was not significantly associated with CHF in this model.

DISCUSSION

In our study, we found that a history of gallbladder surgery, used as an indicator for gallbladder disease, was significantly associated with higher odds of CHF, even after adjusting for demographic and socioeconomic factors. Specifically, individuals who had undergone gallbladder surgery were nearly twice as likely to report CHF compared to those without such a history (OR = 1.90). These findings support the hypothesis that gallbladder disease and CHF may share underlying metabolic and inflammatory pathways. Prior research has identified obesity, insulin resistance, and systemic inflammation as common risk factors for both conditions.[9,10] Our results further suggest that gallbladder pathology requiring surgery could serve as an early indicator of broader metabolic dysfunction, which may eventually manifest as cardiovascular disease, specifically CHF.

Additionally, cholecystectomy may contribute to cardiovascular risk via direct metabolic changes that occur after gallbladder removal. The gallbladder plays a key role in bile acid regulation, which is connected to lipid and glucose metabolism. Cholecystectomy disrupts glucose regulation,

Table 1. Demographic and Clinical Characteristics of Participants by Gallbladder Surgery Status.

Variable	No Gallbladder Surgery N (%)	Gallbladder Surgery N (%)	Total N
Total	6,874 (88.1%)	926 (11.9%)	7,800
Age (Mean ± SD)	52.66 ± 17.63	60.70 ± 14.99	—
Gender			
Male	3,256 (47.4%)	229 (24.7%)	3,485
Female	3,618 (52.6%)	697 (75.3%)	4,315
Race			
Black	902 (15.0%)	91 (10.7%)	993
Hispanic	1,174 (19.5%)	147 (17.3%)	1,321
White	3,939 (65.5%)	614 (72.1%)	4,553
Education			
<9th grade	326 (4.8%)	46 (5.0%)	372
9–11th grade	577 (8.4%)	89 (9.6%)	666
High school/GED	1,504 (21.9%)	241 (26.1%)	1,745
Some college/AA	2,037 (29.7%)	331 (35.8%)	2,368
College graduate	2,408 (35.1%)	217 (23.5%)	2,625
Marital Status			
Married	3,652 (53.3%)	482 (52.2%)	4,134
Not Married	3,201 (46.7%)	441 (47.8%)	3,642

Table 2. Logistic Regression Results Examining the Association Between Gallbladder Surgery and Congestive Heart Failure (CHF).

Variable	Odds Ratio (OR)	95% CI	P-value
Gallbladder Surgery	1.9	1.45 – 2.48	<0.001 ***
Female	0.6	0.47 – 0.77	<0.001 ***
Age (years)	1.07	1.06 – 1.08	<0.001 ***
Not Married	1.44	1.13 – 1.83	0.003 **
Education: 9–11th grade	1.35	0.81 – 2.27	0.252
Education: High school/GED	0.73	0.45 – 1.18	0.21
Education: Some college/AA	0.66	0.41 – 1.08	0.103
Education: College graduate	0.31	0.18 – 0.55	<0.001 ***
Race: Hispanic	0.72	0.46 – 1.13	0.16

Significance Legend: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

normal lipid profiles, and gut microbiota composition, thereby contributing to metabolic dysregulation.[11] This disturbance potentially increases the risk of conditions such as heart failure—even in individuals without traditional risk factors like hypertension or diabetes. This supports the possibility of a biological link between gallbladder surgery and cardiovascular disease, independent of preexisting metabolic conditions.[12,13]

Our findings support the established association between increasing age and the likelihood of developing CHF. Our analysis shows that the risk of CHF rises progressively with age (OR = 1.07), which aligns with earlier research identifying age as a key contributing factor. This trend may be attributed to the gradual buildup of cardiovascular risk factors throughout life, along with the natural deterioration of heart function that occurs with aging.[14,15] Our results also indicated that females had lower odds of CHF (OR= 0.6) which aligns with prior findings indicating a greater risk of CHF among male individuals.[16] Marital status and educational attainment also emerged as important social determinants. Individuals who were not married had increased odds (OR= 1.44) of developing CHF. Those with lower education levels were at increased risk of CHF, highlighting the role of social support and health literacy in cardiovascular health outcomes.[17] Notably, race and ethnicity were not significantly associated with CHF in our adjusted model. The fact that race was not a significant predictor of CHF in the adjusted model suggests that the observed racial disparities in the raw data may be explained by differences in

other factors, such as socioeconomic status and access to healthcare.

LIMITATIONS

This study's limitations include the cross-sectional nature of the NHANES data which precludes determination of causality between gallbladder surgery and CHF. Secondly, the use of gallbladder surgery history as a proxy for gallbladder disease, while practical, does not fully capture the spectrum of gallbladder pathology or disease severity. Additionally, both CHF and gallbladder surgery were self-reported, which may introduce recall or reporting bias. Despite controlling for multiple demographic and socioeconomic variables, the potential for residual confounding remains due to unmeasured factors such as genetic predispositions, obesity, dietary habits, and medication use. Moreover, the use of NHANES data, which represents a specific segment of the U.S. population, may limit the external validity of these findings when applied to other populations or settings.

Lastly, this analysis does not investigate the biological processes that may account for the association between gallbladder disease and CHF. This underscores the importance of future clinical and laboratory studies aimed at uncovering the underlying mechanisms linking gallbladder disease and cardiovascular outcomes.

CONCLUSION

In conclusion, our study demonstrated a significant association between a history of gallbladder surgery and increased odds of congestive heart failure, even after accounting for key demographic and socioeconomic variables. These findings highlight the importance of considering risk assessment for cardiovascular disease in patients with gallbladder disease. The association may be due to shared metabolic and inflammatory pathways underlying gallbladder and cardiovascular diseases, or due to direct metabolic changes that occur post cholecystectomy. These findings suggest that routine follow-up care after gallbladder removal may benefit from incorporating cardiovascular risk assessments, particularly among individuals with additional comorbidities. The data also highlighted differences in CHF risk across demographic groups, indicating a need for clinical guidelines that consider both biological and social determinants of health. Further research is necessary to better understand the biological mechanisms underlying the association between gallbladder disease and cardiovascular disease. Ultimately, recognizing gallbladder surgery, as a potential early marker for cardiovascular risk could prompt earlier interventions and better management of patients to mitigate adverse cardiac events.

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