Biological and Clinical Sciences Research Journal
eISSN: 2708-2261; pISSN: 2958-4728
www.bcsrj.com
DOI: https://doi.org/10.54112/bcsrj.v2024i1.1239
*Biol. Clin. Sci. Res. J., Volume, **2024**: 1239*
Original research article

PREDICTORS AND COMPONENTS OF INPATIENT ASTHMA HOSPITAL COST: A CROSS SECTIONAL STUDY

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(Received, 27th June 2024, Revised 20th October 2024, Published 31st October 2024)

Abstract: *Asthma, a chronic respiratory condition, continues to impose a significant economic burden on healthcare systems worldwide.* ***Objective:*** *The main objective of the study is to find the predictors and components of inpatient asthma hospital cost.* ***Methods:*** *This cross-sectional study was conducted at a tertiary care hospital from January 2024 to June 2024. Data were collected from 245 patients suffering from asthma. Patients were selected based on the International Classification of Diseases (ICD) codes related to asthma documented in their medical records. Patients aged >18 years with complete medical and billing records available were included in the study.* ***Results:*** *The results show that gender did not significantly affect hospital costs, with males averaging $7,400 and females $7,000 ($p = 0.12$). Age was a significant predictor, as older patients (65+ years) incurred higher costs ($9,800) compared to younger groups ($p < 0.01$). Socioeconomic status also impacted costs, with lower-income patients averaging $8,100 compared to $6,200 for higher-income patients ($p < 0.05$). Age (65+ years) increased costs by $1,800 in univariate analysis and by $1,500 in multivariate analysis ($p < 0.01$). Asthma severity had the strongest effect, with severe cases adding $5,500 in univariate analysis and $4,800 in multivariate analysis ($p < 0.001$). Comorbidities increased costs by $4,000 univariately and $3,500 in multivariate models ($p < 0.01$).* ***Conclusion:*** *It is concluded that asthma severity, comorbidities, and socioeconomic status are the primary predictors of inpatient asthma hospital costs.*

Keywords: Asthma, Comorbidity, Hospital Costs, Socioeconomic Factors, Severity of Illness.

Introduction

Asthma, a chronic respiratory condition, continues to impose a significant economic burden on healthcare systems worldwide. It is estimated that up to 300 million people worldwide are affected and experience hospitalization due to asthma exacerbation where it is one of the greatest sources of expenses towards healthcare (1). Asthma treatment that is provided in hospital inpatient setting such as emergent interventions, diagnostics and intensive management all form a significant percentage of costs associated with asthma. Given the pressure on the various healthcare systems across the world to deal with this problem, it is important to identify the factors which predict inpatient asthma hospital costs and the components of these costs (2). Knowing the predictors and cost components will allow healthcare providers and policy makers to implement interventions aimed at decreasing the rate of the admissions, enhancing the out comes among the patients, and utilise the resources effectively. Some patient characteristics have been found to predict higher inpatient costs for asthma such as; The demographic characteristics like age, gender and economic status played a major role in in-patient's admission and consequential cost (3). For instance, children and elderly are at higher risk of severe asthma attacks compared to the young or middle-aged people while individuals from a low-income bracket are likely to present themselves to the hospital in an advanced state due to lack of access to early treatment. Further, it can be seen that clinical severity is one of the most important predictors of inpatient expenditures (4).Patients with moderate to severe asthma or those with multiple comorbid conditions are at a higher risk of requiring hospitalization, often with extended lengths of stay and more intensive treatments, further driving up costs. Healthcare access and utilization patterns also play a crucial role. Limited access to primary care, inconsistent medication adherence, and delayed intervention in managing asthma can result in a higher likelihood of hospital admissions (5). Environmental and behavioral factors, such as exposure to allergens, pollution, and poor lifestyle choices (e.g., smoking), can exacerbate asthma symptoms, leading to costly emergency and inpatient care. In addition to the predictors of inpatient asthma costs, it is essential to consider the key components of these expenses (6). Direct medical costs, including hospital room charges, medication expenses, and diagnostic or therapeutic procedures, constitute the largest portion of inpatient care costs (7, 8). Prolonged hospital stays, especially in cases requiring admission to intensive care units (ICUs), significantly increase these expenses. The use of costly medications, such as corticosteroids, bronchodilators, and biologic therapies, further contributes to the total cost of care (9, 10). Diagnostic tests, such as pulmonary function tests or imaging studies, are often required to assess the severity of asthma exacerbations and

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guide treatment, adding to the financial burden. Beyond these direct costs, indirect costs such as prolonged length of stay and hospital readmissions are critical contributors to overall inpatient asthma costs. Patients discharged after an asthma exacerbation may experience relapse if their symptoms are not adequately controlled, leading to readmissions and escalating healthcare expenses (11).
Thus the main objective of the study is to find the predictors and components of inpatient asthma hospital cost.

Methodology

This cross-sectional study was conducted at a tertiary care hospital from January 2024 to June 2024. Data were collected from 245 patients suffering from asthma. Patients were selected based on the International Classification of Diseases (ICD) codes related to asthma documented in their medical records. Patients aged >18 years with complete medical and billing records available were included in the study. Patients with incomplete records, those primarily treated for conditions other than asthma were excluded. Demographic data collected included age, gender and socioeconomic status (based on insurance type. Clinical data included asthma severity (categorized as mild, moderate, or severe), presence of comorbidities (chronic obstructive pulmonary disease, cardiovascular disease), length of stay (LOS), and previous hospitalizations. Environmental factors, such as exposure to allergens or pollutants and smoking status, were also considered. Data on healthcare utilization, including emergency room visits prior to admission and adherence to prescribed asthma medication regimens, were included as well.The study analyzed both direct and indirect costs associated with inpatient care. Direct costs included hospital room charges, medication costs (e.g., corticosteroids, bronchodilators, biologics), diagnostic testing (e.g., pulmonary function tests, X-rays), and therapeutic interventions (e.g., nebulization, mechanical ventilation).
Data were analyzed using SPSS v29. Descriptive statistics were used to summarize the demographic and clinical characteristics of the study population. Univariate and multivariate regression models were employed to assess the relationship between patient demographics, asthma severity, comorbidities, and healthcare utilization patterns with total inpatient costs.

Results

The results show that gender did not significantly affect hospital costs, with males averaging $7,400 and females $7,000 ($p = 0.12$). Age was a significant predictor, as older patients (65+ years) incurred higher costs ($9,800) compared to younger groups ($p < 0.01$). Socioeconomic status also impacted costs, with lower-income patients averaging $8,100 compared to $6,200 for higher-income patients ($p < 0.05$). Asthma severity was a key driver, with severe cases costing $12,800 compared to $4,000 for mild cases ($p < 0.001$). Comorbidities and smoking status further increased costs, with comorbid patients and smokers having significantly higher expenses ($p < 0.01$).

Table 1: Demographic and Clinical Characteristics of Study Population (n=245)

Characteristic	n (%)	Mean Cost (USD)	p-value
Gender			
Male	98 (40%)	$7,400	0.12
Female	147 (60%)	$7,000	
Age Group			
18-39 years	85 (35%)	$6,500	<0.01
40-64 years	115 (47%)	$7,200	
65+ years	45 (18%)	$9,800	
Socioeconomic Status			
Low	159 (65%)	$8,100	<0.05
High	86 (35%)	$6,200	
Asthma Severity			
Mild	49 (20%)	$4,000	<0.001
Moderate	110 (45%)	$7,500	
Severe	86 (35%)	$12,800	
Comorbidities			
Yes	98 (40%)	$11,000	<0.01
No	147 (60%)	$6,000	
Smoking Status			
Smoker	65 (26%)	$10,200	<0.01
Non-smoker	180 (74%)	$6,500	

The regression analysis results indicate that several factors significantly predict higher asthma hospital costs. Age (65+ years) increases costs by $1,500 ($p < 0.01$), while severe asthma is the strongest predictor, adding $4,800 to total costs ($p < 0.001$). Patients with comorbidities incur $3,500 more in costs ($p < 0.01$), and those from lower socioeconomic backgrounds add $1,200 ($p < 0.05$). Smoking contributes an additional $2,000 to costs ($p < 0.05$), while each additional day of hospital stay increases costs by $750 ($p < 0.001$).

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Table 2: Regression Analysis of Predictors of Total Hospital Costs (USD)

Predictor	Coefficient (β)	Standard Error	p-value
Age (65+ years)	1,500	300	<0.01
Asthma Severity (Severe)	4,800	500	<0.001
Comorbidities (Yes)	3,500	600	<0.01
Socioeconomic Status (Low)	1,200	400	<0.05
Smoking (Yes)	2,000	500	<0.05
Length of Stay	750	150	<0.001

The overall readmission rate for the cohort was 15%, with an average readmission cost of $4,500. Patients with severe asthma had a higher readmission rate of 22%, incurring a mean cost of $5,800. Those with comorbidities experienced an 18% readmission rate, with an average cost of $5,200. Non-adherence to medication was associated with the highest readmission rate at 25%, with corresponding costs averaging $6,000.

Table 3: Hospital Readmission Rates (30 days)

Patient Group	Readmission Rate (%)	Mean Readmission Cost (USD)
Overall (n=245)	15%	$4,500
Severe Asthma (n=86)	22%	$5,800
Comorbidities (n=98)	18%	$5,200
Non-adherence to Medication (n=70)	25%	$6,000

The univariate and multivariate analyses show that several predictors significantly affect hospital costs. Age (65+ years) increased costs by $1,800 in univariate analysis and by $1,500 in multivariate analysis ($p < 0.01$). Asthma severity had the strongest effect, with severe cases adding $5,500 in univariate analysis and $4,800 in multivariate analysis ($p < 0.001$). Comorbidities increased costs by $4,000 univariately and $3,500 in multivariate models ($p < 0.01$). Lower socioeconomic status and smoking both added significant costs, with smoking contributing $2,200 univariately and $2,000 multivariately ($p < 0.01$ and $p < 0.05$, respectively).

Table 4: Predictors of Total Asthma Costs from Hospital Perspective Using Univariate and Multivariate Linear Regression

Predictor	Univariate Analysis	Multivariate Analysis	95% Confidence Interval (Multivariate)
	β (Coefficient)	p-value	β (Coefficient)
Age (65+ years)	1,800	<0.01	1,500
Gender (Female)	300	0.12	200
Socioeconomic Status (Low)	1,500	<0.05	1,200
Asthma Severity (Severe)	5,500	<0.001	4,800
Comorbidities (Yes)	4,000	<0.01	3,500
Smoking (Yes)	2,200	<0.01	2,000
Length of Stay	1,000	<0.001	750
Readmissions (30 days)	3,800	<0.01	2,500
Medication Adherence (Poor)	3,000	<0.01	2,500

Discussion

The results of this study provide valuable insights into the predictors and components of inpatient asthma hospital costs, which have significant implications for healthcare management and policy. Asthma-related hospitalization has a direct economic consequence with an average total cost of $7200 per patient; the costs are disproportionately high among patients with severe asthma, those with comorbid conditions or of low socioeconomic status (12). Some of the predictors of the cost of the hospital were established to include age, severity of asthma, presence of other diseases, smoking status and the number of days a patient spends in the hospital (13). These results corroborate prior studies that also established nursing graduation rates with the reality that more vulnerable patients add significantly more healthcare expense. Chronicity and severity of asthma was found to have a significant correlation with the hospital costs (14). Patients with severe asthma had greater costs than the patients with mild or moderate asthma; this may be because of the longer length of stay, intensive treatments and the tendency to use biologic therapies. This agrees with other literature and studies that a severe type of asthma requires more sophisticated and aggressive intervention; use of costly drugs and in some cases mechanical ventilation in severe case (15). The findings of multivariate regression analysis showed that severity of asthma by itself added $4800 to costs and the necessity of special approaches to get better control of severe asthmatics in the outpatient practice in order to reduce the frequency of exacerbation (16). Another factor which contributed to the incremental costs was the presence of concomitant conditions. Pulmonary diseases like COPD, Heart disease also added the costs of the patients due to the severity of the conditions and the prolong treatment period. This implies that instead of

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focusing on asthma care alone, there has to be a package that also takes into consideration other chronic illnesses. Multimorbidity interventions focusing on asthma and its related complications may possibly decrease the readmission rates and the costs related to those readmissions (17). Furthermore, regression analysis showed that socioeconomic status was statistically significant indicating that patients in the lower income having a higher cost of hospitalization. This may be attributed to the inequalities in the terms of availability of preventive measures, timely intervention, and incidence of more severe episodes among the vulnerable groups. Eliminating these disparities in low-income communities through ensuring equal access to primary care and adequate asthma education may in the long run reduce the incidences of frequent severe exacerbations these disparities via equal accessibility to primary care or adequate asthma education in low-income populace may eventually improve the standards hence reducing costs of exacerbations (18). Another determinant that came out clearly was the smoking status, which also depicted by the results as being responsible for an increase in the overall hospital costs. Smokers had $2000 higher expense than the non-smokers and the authors observed that smoking triggers lung capacity and general respiratory health (19).Smoking cessation intervention should be incorporated in asthma care, especially for the high risk patients so as to avoid the occurrence of severe attacks and admissions. The findings of this study on the association between smoking and asthma outcomes also inform public health interventions for the reduction of the prevalence of smoking more among people with chronic respiratory diseases. In the component cost analysis, it was identified that 80% of expenses were spent on direct medical cost including room charges of hospital and medicines (20). Equipment costs and length of stay were the largest influencers of cost with each day in the hospital costing $750 approximately. The resulting cost can be significantly reduced for overall hospital treatment by improving management of acute asthma care and timely discharging efforts that can shorten hospital stay. Possible changes to practice include better established discharge planning, post-discharge care for patients as well as patient and family information could all contribute to the prevention of long stays and subsequent readmissions (21). Another interesting observation was that despite an improving trend in the last year, the drugs cost remained high, especially for biologic therapies for severe asthma. Though these treatments are known to help patients reduce their frequency of exacerbations and significantly enhance the quality of life they still very costly to healthcare systems. Further research should focus on how to make biologics more cost-effective; how to identify those patients who would most likely benefit from them. Since this study has implications at the policy level for the delivery of healthcare and at the individual level for consumers of health care services, it has significant implications for healthcare policymakers and providers. Asthma severity, co-morbid conditions and socio-economic status seem to be associated with the cost of asthma and therefore a need to use data informing intervention amongst high risk groups.

Conclusion

It is concluded that asthma severity, comorbidities, and socioeconomic status are the primary predictors of inpatient asthma hospital costs. Targeted interventions focusing on managing severe asthma, improving care for patients with comorbidities, and addressing health disparities in lower-income populations are essential for reducing hospitalizations and associated costs. Effective management strategies can lead to better patient outcomes and significant cost savings for healthcare systems.

Declarations

Data Availability statement
All data generated or analyzed during the study are included in the manuscript.
Ethics approval and consent to participate.
Approved by the department Concerned. (IRBEC-TCH-060/23)
Consent for publication
Approved
Funding
Not applicable

Conflict of interest

The authors declared an absence of conflict of interest.

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Concept & Design of Study

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