



**INSTITUTE OF HEALTH SCIENCES  
SCHOOL OF NURSING AND MIDWIFERY  
DEPARTMENT OF NURSING**

**DETERMINANTS OF READMISSION FOR ACUTE ASTHMA  
AMONG ADULT PATIENTS IN PUBLIC HOSPITALS NEKEMTE  
TOWN, SOUTH WEST ETHIOPIA: CASE-CONTROL STUDY**

**BY: MOHAMMED NESRU UMAR (Bsc)**

A THESIS SUBMITTED TO WOLLEGA UNIVERSITY, INSTITUTE OF  
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**WOLLEGA UNIVERSITY  
INSTITUTE OF HEALTH SCIENCES**

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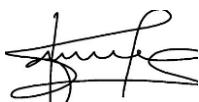
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**May 2025  
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As members of the Board of Examining of the Final MSc. thesis open defense, we certify that we have read and evaluated the thesis prepared by Mohammed Nesru under the title “Determinants of Readmission for Acute Asthma Among Adults in Public Hospitals Nekemte Town” and recommend that the thesis be accepted as fulfilling the thesis requirement for the Degree of Master of Adult Health in Nursing

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## LIST OF ABBREVIATIONS AND ACRONYMS

ATS: American Thoracic Society

BTS: British Thoracic Society

CBHI: Community-Based Health Insurance

CHS: College of Health Sciences

ED: Emergency Department

GBD: Global Burden of Disease

G.C: Gregorian Calendar

GERD: Gastroesophageal Reflux Disease

GINA: Global Initiative for Asthma

HRRP: Hospital Readmission Reduction Program

HRQoL: Health-Related Quality of Life

ICD-11: International Classification of Diseases 11 Revision

ICS: Inhaled Corticosteroids

ICU: Intensive Care Unit

OCS: Oral Corticosteroid

SABA: Short-acting beta Agonist

SPSS: Statistical Package for Social Sciences

URTI: Upper Respiratory Tract Infection

WHO: World Health Organization

WU: Wollega University

WUCSH: Wollega University Comprehensive Specialized Hospital

WUIHSERC: Wollega University's Institute of Health Science Ethics Review Committee

## ABSTRACT

**Background:** Asthma-related readmissions pose significant challenges to healthcare settings, increasing costs and resulting in poorer patient health outcomes. Little is known about the factors that contribute to readmission for acute asthma.

**Objective:** This study aimed to identify the determinants of readmission for acute asthma among adult patients in Public Hospitals in Nekemte Town, South West Ethiopia.

**Methods and Materials:** A hospital-based retrospective chart review was conducted among 110 cases and 220 controls at public hospitals in Nekemte town from August 25, 2021, to October 24, 2024. Patients with readmission for acute asthma within 90 days were considered cases, and those with acute asthma who were admitted and readmitted more than 90 days after their index discharge were considered controls. The data collection tool was adapted from previous studies on acute asthma readmission and reviewed for content validity by experts, clinicians, academic advisors, and peers. Epi Data Manager was used for data entry, and SPSS for Windows version 26 was used for data analysis. Logistic regression was employed to assess the association between acute asthma readmission and independent variables. Statistical significance is set at a p-value of  $< 0.05$ .

**Result:** A total of 330 participants, including 220 controls and 110 cases with acute asthma, participated in the study. Middle-aged adults are associated with a higher likelihood of readmission for acute asthma (AOR=3.3, 95% CI=1.3-8.6). In addition, last year's unexpected ED visits (AOR= 2.2, 95% CI= 1.2-3.9), prior year's hospitalization (AOR=2.4, 95% CI= 1.3–4.3), longer stay at index admission (AOR=2.4, 95% CI=1.3–4.3), years since asthma diagnosis (AOR= 2.4, 95% CI= 1.3-4.4) and high eosinophil count (AOR=2.6, 95% CI=1.8–3.8) were significantly associated with readmission for acute asthma.

**Conclusion:** The study found that middle-aged adults with past unplanned ED visits or hospitalizations last year, longer hospital stays, prolonged asthma symptoms, and elevated eosinophil counts were more likely to be readmitted for acute asthma after discharge. It is essential to provide targeted and suitable treatment approaches for older adults with acute asthma who have a history of previous hospital admissions and unplanned emergency department visits, prolonged duration of asthma episodes, extended hospital stays, and elevated eosinophil counts upon initial admission.

**Keywords:** Acute asthma, Asthma risk factor, Determinants of readmission for acute asthma

# 1. INTRODUCTION

## 1.1. Background

Asthma is a chronic condition characterized by airway inflammation, which causes symptoms such as wheezing, chest tightness, coughing, and breathlessness (1). Various factors, including family history, allergies, low birth weight, tobacco smoke exposure, air pollution, and workplace chemicals, influence asthma development (2). The prevalence of asthma is increasing worldwide, and surveys indicate that the majority of patients in developed and developing countries do not receive optimal care and are therefore not well controlled (3).

Hence, exacerbated asthma symptoms require a change in the dose of the medication for mild asthma symptoms; however, severe asthma exacerbation is life-threatening and requires a baseline assessment of severity, close monitoring, and frequent reassessment (3). However, it is essential to acknowledge that managing asthma is relatively straightforward for most patients when treatment is consistently and appropriately administered (3). Most patients experience considerable advantages from administering low-dose inhaled corticosteroids, frequently in conjunction with an additional controller. Nevertheless, certain individuals may not achieve optimal results with low doses (3). Furthermore, a few patients may not benefit from even higher doses of inhaled corticosteroids (4). Additionally, a select few may require advanced biomarker monitoring, provided the fundamental parameters are well established (4).

Uncontrolled asthma can severely affect daily activities and lead to significant healthcare costs (5). A study in Ethiopia found that uncontrolled asthma affects 64.5% of asthma patients, underscoring the need for improvements in healthcare practices (6). Unchecked asthma symptoms lead to frequent exacerbations with progressive or abrupt worsening of asthma symptoms, characterized by increased use of bronchodilators and a diminished response over time, as well as a decrease in pulmonary function measured by peak expiratory flow (PEF) (3).

Additionally, a recent study revealed that the frequency of asthma follow-up contacts is insufficient, with only one-third of patients with asthma attending a planned visit each year (3), as recommended by guidelines (3). Furthermore, the survey done in eleven European countries among eight thousand adults with asthma showed that acute exacerbations were common and that 12% of the patients with asthma had been hospitalized because of asthma

during the previous year (3). There is a need for better monitoring of asthma patients, particularly after they have been hospitalized due to asthma(7). There is evidence indicating that a history of asthma rehospitalization is one of the prominent risk factors for mortality (8).

Hospital readmission shortly after discharge is a key indicator of care quality(9). Asthma-related readmissions can be viewed as a measure of health system performance in managing patients diagnosed with asthma(9). The inpatient care rendered during the preceding hospitalization, the effectiveness of discharge strategies, and the community-based care provided post-discharge may affect the probability of re-admission. In one systematic review, it was observed that between 9% and 48% of re-admissions were linked to demonstrable instances of substandard care during the hospitalization process (10). As noted above, readmission to the hospital for asthma is related not only to the quality of care in the hospital (11) but also to the complexity of comorbid disease, premature discharge, inadequate preparation of the patient or family, and poor care transition back to the community.

Nevertheless, readmission for acute asthma may not be preventable for certain patients due to inherently severe asthma; however, it should not occur within three months following the index discharge (3). Identifying the determinants of 90-day readmission for acute asthma is essential, as this information can be utilized to enhance both in-hospital and post-hospitalization patient management, ultimately aiming to reduce subsequent readmissions. Addressing these factors through targeted interventions and implementing personalized treatment strategies is vital for decreasing these readmissions.

## 1.2. Statement of the Problem

Hospital admissions for acute asthma represent significant events that adversely impact patients' quality of life, healthcare resource utilization, and associated costs (5). Indeed, readmissions related to acute asthma pose considerable challenges, resulting in heightened healthcare expenditures and negative health outcomes (3). In 2019, around 262 million people globally had asthma, leading to 455,000 deaths (12), primarily in low- and middle-income countries due to barriers in diagnosis and treatment (13). Every year, 49% of people with asthma encounter exacerbation (14). In addition, 10% of the patients presenting to the emergency department were attributed to acute asthma attacks, and 7% of these patients were admitted due to their condition (15). Studies also show that the early readmission for acute asthma ranges from 10% to 30%, indicating the need for targeted interventions (16, 17). Moreover, late readmission for acute asthma after hospital discharge within 90 days is 26% (18) and as high as 40% within 6 months (19) and 47% in the following year of the index admission (20, 21). A study in Ethiopia reported that eighteen percent of early readmissions were for asthma episodes (16).

These adverse implications of acute asthma flare-ups are far-reaching and severe, ranging from mild to life-threatening (22). Importantly, asthma flare-ups result in absenteeism from school and work, frequent emergency visits, reduced quality of life, hospital admissions, and, in the most severe cases, even death (23) (24). Furthermore, hospital admissions and readmissions for acute asthma account for nearly three-quarters of the direct cost of asthma (25). Moreover, readmitted patients with acute asthma hurt their emotional and physical well-being, reduce school performance, and quality of life (26, 27), impair patient functioning, and consume significant healthcare resources (21). As a result, early readmissions (admissions within 30 days of the initial hospitalization) appear to identify patients with an increased risk of morbidity and possible mortality (28).

A variety of demographic, clinical, and healthcare risk factors have been identified to hospital readmissions among patients with asthma. These factors encompass advanced age, female gender, the presence of multiple comorbidities, receipt of care in an urban hospital environment, prior hospital admissions, unplanned visits to the emergency department, and extended hospital stays (29). Furthermore, evidence indicates that late readmissions for acute asthma are correlated with extended durations of oxygen therapy (16), membership in a lower socioeconomic class (23, 30, 31), exposure to asthma triggers (32-35), disparities in healthcare access (36-38), experiencing severe asthma attacks during the initial

admission (39), and recent hospitalizations due to acute asthma (21). Conversely, early readmissions for acute asthma are linked to inadequate treatment received in the emergency department during the initial visit, insufficient patient education before discharge from the hospital, absence of arrangements for post-discharge care (40-42), and potential abuse or dependence on prescription medications such as opioids, anxiolytics, sedatives, and hypnotics (43).

While not all readmissions are entirely preventable, it is widely recognized that some unplanned readmissions could be avoided by addressing various barriers patients encounter before, during, and after admission and discharge. The Medicare Hospital Readmissions Reduction Program (HRRP) aims to lower hospital readmissions (44). Penalizing high readmission rates, HRRP encourages hospitals to improve patient education, self-management, and care transitions, enhancing overall patient support and care quality. Furthermore, comprehensive asthma education—incorporating dedicated asthma educators, structured discharge planning, prescribing oral corticosteroids and ICS medications on index discharge, effective communication, and strengthening after-discharge activities such as home visits—has been shown to decrease readmission for acute asthma (45). Policy-focused interventions to reduce exposure to pollutants and allergens have also improved asthma symptoms and reduced unexpected hospital visits (2). As a result of these initiatives, there has been a significant improvement in asthma-related emergency department visits, healthcare expenditures, reimbursements, and a reduction in hospital readmissions (19).

Understanding the fundamental reasons behind asthma readmissions is essential for guiding the treatment provided to patients experiencing acute asthma in public health institutions. In Ethiopia, there is limited knowledge regarding the determinants of readmission for acute asthma (16). Moreover, prior research has not examined demographic, clinical, and healthcare variables simultaneously. A comprehensive understanding of socio-demographic and clinical characteristics, alongside healthcare factors, is vital for delivering patient-centered care. Consequently, this study aimed to investigate the factors associated with readmission for acute asthma among adult patients in public hospitals in Nekemte Town, South West Ethiopia, in 2024.

### 1.3. Significance of the Study

**For Hospital managers:** The findings of this study will help hospital administrators manage and improve the standard of care provided to patients with asthma. Standardized and qualified care may reduce readmissions for acute asthma and healthcare expenditure.

**For the patient:** This study's findings can benefit patients with acute asthma by providing information on the determinants of readmission and identifying features of future readmission risk factors. Reduced readmission can improve their quality of life, reduce healthcare costs, and increase productivity.

**To policymakers:** The findings may assist policymakers in formulating qualified and accessible asthma care, minimizing financial hardship and geographical constraints. Furthermore, these findings can encourage policymakers to devise a health insurance reimbursement policy for hospitals to reduce avoidable hospital readmissions.

**For researchers:** The findings of this study will provide researchers with baseline data on determinants of 90 days readmission for acute asthma. Additionally, this study fulfills knowledge gap related to 90 day readmission for acute asthma in south west Ethiopia.

## 2. LITERATURE REVIEW

Multiple factors can determine readmission for acute asthma. Preventing hospital readmissions is a key aspect of asthma care, as they can be costly, disruptive to patients' lives, and indicate suboptimal disease control (46). Investigating the determinants of readmission for acute asthma allows us to intervene in those avoidable readmissions. The relationship between sociodemographic, environmental, clinical, and healthcare quality of care and readmission for acute asthma has been investigated, however, the findings are inconsistent and contradictory (47-49). Accordingly, focusing on the most relevant variables based on evidence will be vital to solving the problem.

### 2.1. Socio-demographic Factors Associated with Readmission for Acute Asthma

Studies indicate that some sociodemographic profiles are important in determining readmission for acute asthma (31, 50-52). Studies have found that age, gender, and health insurance enrollment are the most often reported sociodemographic factors associated with acute asthma readmission (17, 29, 38, 53, 54).

#### 2.1.1. Age

Research evidence showed that age is an important factor in determining the likelihood of readmission for acute asthma (55). Accordingly, asthmatic older adults with additional chronic diseases, such as cardiovascular diseases or diabetes, can complicate asthma management and increase the risk of readmission (56). Similarly, a study reported that advanced age (above 65) had a higher rate of acute asthma readmission compared to younger adults (29). However, in Ethiopia, age-related acute asthma readmission remains unknown.

#### 2.1.2. Gender

Gender differences in acute asthma readmission rates may arise due to biological, social, environmental, and healthcare access factors (20). A study conducted in 2016 in the USA found that the odds of readmission for acute asthma were associated with being female (17). In contrast, a study in Ethiopia showed that acute asthma readmissions were higher among male patients (54). These studies presented contradictory results, and further investigation was needed to identify the role of gender in readmission for acute asthma.

### 2.1.3. Health Insurance

One can estimate that acute asthma patients with lower incomes may live in environments with more triggers, like allergens and pollutants, and have fewer resources for effective self-management. This leads to limited access to quality healthcare, including preventive care and medications, often leading to more severe asthma attacks requiring hospitalization. A study showed that in the USA, acute asthma patients without public health insurance have a higher rate of acute asthma readmission (53). In contrast, a study in Western Europe reported that higher readmission for acute asthma was consistently funded through public health insurance (29). In addition to the inconsistencies observed in the study results, there is a notable lack of evidence in Ethiopia regarding the association of health insurance with readmission for acute asthma.

## 2.2. Clinical Factors Associated with Readmission for Acute Asthma

Identifying clinical factors associated with readmissions is crucial for improving care and reducing hospitalizations. As highlighted in various research studies, asthma readmissions can stem from different clinical causes (16, 17, 43, 57). The clinical factors reported were contradictory and conflicting.

### 2.2.1. Comorbidity Disease

Acute asthma patients who have additional chronic health conditions complicate asthma management and increase the risk of readmissions (50). Accordingly, a study done in 2016 in Switzerland showed that a history of GERD is the primary predictive factor for early asthma readmissions (17). Similarly, a study done in the US indicates that acute asthma patients presenting with GERD and Rhinosinusitis had a higher rate of acute asthma readmission (43, 50, 58). However, the evidence remains unknown in Ethiopia.

### 2.2.2. Previous Year Admission and ED Visit

Individuals hospitalized for asthma-related issues, like a significant exacerbation, could face a higher risk of being readmitted to the hospital in the short term (59). Individuals presenting with more severe asthma disease at baseline are at significantly higher risk of experiencing acute exacerbations that require hospitalization and, consequently, increase the risk of readmission (48). Studies in the US reported that patients with a history of frequent emergency department (ED) visits and/or hospitalizations for acute asthma disease are more likely to experience acute asthma readmission (43, 58). Consistently, a study conducted in 2020 in Ethiopia showed that multiple hospitalizations per year were independent predictors of 30-day readmission (16).

In conclusion, research has shown that several clinical factors are associated with acute asthma readmission. The variation in acute asthma readmission rates among patients suggests that clinical factors vary by population and context. Obtaining clinical factors consistent across all settings and for all asthma patients is challenging.

### 2.3. Healthcare Related Factors Associated with Readmission for Acute Asthma

Acute asthma readmissions, often occurring within 30 days of hospital discharge, are a significant challenge in asthma management (60). Various healthcare-related factors can influence readmissions of acute asthma. Understanding these factors is crucial for developing strategies to reduce readmission rates and improve patient outcomes (52). Most studies focused on clinical, sociodemographic, patient-related, and healthcare factors associated with readmission for acute asthma (16, 17, 46, 47, 59, 61). Here are some key healthcare-related factors associated with readmission for acute asthma.

#### 2.3.1. Treatment-related factors

Proper and timely management of acute asthma episodes is vital (62). Patients who do not receive adequate, appropriate, and prompt prescriptions of systemic steroids and bronchodilators at admission may experience worsening symptoms, leading to readmission (63). Some patients with ongoing airway inflammation may face readmission after discharge, despite receiving corticosteroid treatment (64, 65). According to the audit report, hospitals that initiate systemic corticosteroid and bronchodilator treatment within one hour of presentation demonstrated reduced acute asthma readmission rates (66).

#### 2.3.2. Discharge-related Factors

Effective discharge planning is essential for preventing acute asthma readmissions (49). Patients who leave the hospital without a clear understanding of their asthma management plan, including medication instructions and follow-up appointments, are at higher risk for readmission (58). Research evidence indicated that hospitals prescribing short-course oral corticosteroids before hospital discharge and increasing the dose of ICS upon hospital discharge reduce the risk of early acute asthma readmission (49). Hospitals with strict assessment and coordinated follow-up, including effective hospital discharge, have shown a reduction in readmission rates (48).

#### 2.3.3. Eosinophil Count

Recent studies suggest a link between high blood eosinophil counts and an increased risk of asthma exacerbations, especially in patients with poorly controlled asthma (67, 68). In the US, a study reported that patients with severe asthma were more likely to have asthma-

related hospital admissions, particularly for an elevated blood eosinophil count, defined as greater than  $0.4 \times 10^9$  cells/L, compared to patients with counts less than  $0.4 \times 10^9$  cells/L (69). In the UK, patients with severe uncontrolled eosinophilic asthma (blood eosinophil count  $>0.3 \times 10^9$  cells/L) experienced more than seven times the annual hospitalizations compared to the general asthma population (5), while in Finland, the same eosinophil count was linked to a 13% higher rate of hospital admissions among asthma patients (70).

Healthcare-related factors play a significant role in reducing the risk of acute asthma readmission among adults (63). Improving discharge planning, ensuring access to follow-up care, managing medications effectively, addressing comorbid conditions, and providing culturally competent education is essential in reducing readmission rates (28).

Therefore, readmission for acute asthma is a multifactorial issue that includes a complex interplay of clinical, socio-demographic, and healthcare-related factors (62). Addressing hospital readmissions while caring for diverse populations is a major concern due to its implications for cost and quality. Hospitals need clearer guidance on system-wide redesign and targeted efforts to prevent readmissions among vulnerable populations. To understand this health problem, the study explored the demographic, clinical, and healthcare factors that led to readmission for acute asthma among adults in Public Hospitals in Nekemte Town, Ethiopia, in 2024.

## 2.4. Conceptual Framework

This framework was developed following a comprehensive and critical literature review on acute asthma readmissions (11, 16, 17, 43, 48, 49, 54, 58, 66, 71-73). The conceptual framework for the relationship between acute asthma readmission and several independent variables is designed based on the findings of studies in online databases.

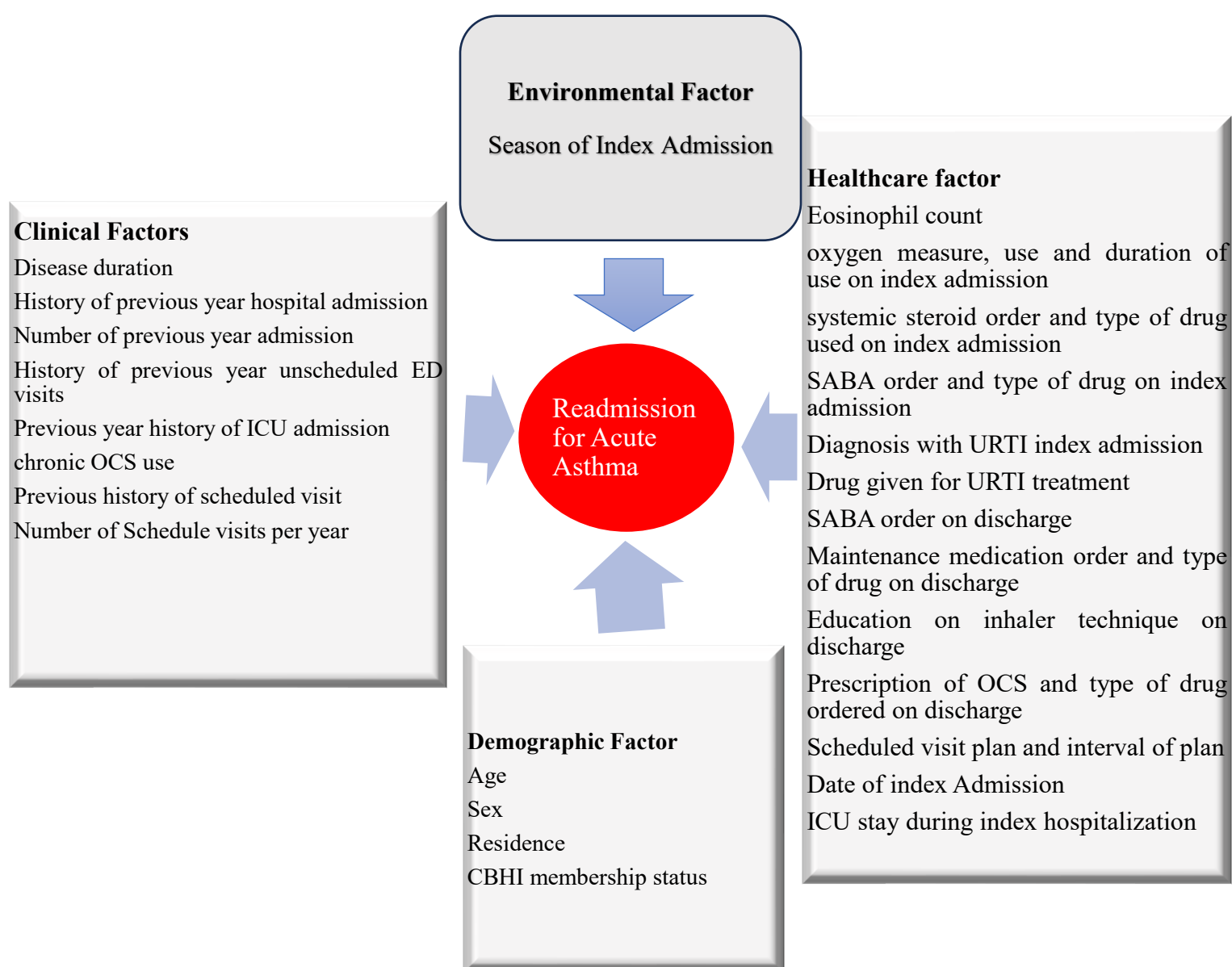


Figure 1: Conceptual Framework Developed After Reviewing Literature

### 3. OBJECTIVES

#### 3.1. General Objective

To assess the determinants of readmission among admitted adults with acute asthma in Public Hospitals in Nekemte Town, South West Ethiopia, in 2024.

#### 3.2. Specific Objective

To identify the determinants of readmission among admitted adults with acute asthma in Public Hospitals in Nekemte Town, South West Ethiopia, in 2024.

## 4. METHODS and MATERIALS

### 4.1. Study Area and Period

The study was conducted in selected public hospitals located in Nekemte Town, South West Ethiopia. The Nekemte Comprehensive Specialized Hospital and the Wollega University Comprehensive Specialized Hospital are situated in the East Wollega Zone of Nekemte. This town is positioned 352 kilometers from Addis Ababa, the capital city of Ethiopia. According to estimates from the Oromia Regional Health Bureau (2018), the region is classified as 39% semi-arid, 49% warm, and 12% temperate. In the preceding year, the Nekemte Comprehensive Specialized Hospital accommodated 178,217 patients, while the Wollega University Comprehensive Specialized Hospital attended to 188,714 patients. Both hospitals offer healthcare services to inpatients and outpatients and accept referrals from nearby hospitals, health centers, and clinics.

These hospitals can accommodate between 268 and 311 beds. Physicians and nurses with Bachelor of Science degrees oversee the medical inpatient units at both facilities. Male and female patients can have separate accommodations. Modern medical technology, including integrated oxygen supply systems and monitoring devices, is connected to every hospital bed to monitor patients. The inpatient department statistics from the previous year show that WUCSH admits roughly 277 patients per month, compared to about 210 at NCSH (74). The study period was conducted from December 2024 to January 2025.

### 4.2. Study Design

An institution-based case-control study design was employed.

### 4.3. Population

#### 4.3.1. Source Population

The source population was readmitted and admitted all acute asthma patients to public hospitals in Nekemte town, Ethiopia, between August 25, 2021, and October 24, 2024.

#### 4.3.2. Study Population

The study population was selected adult patients with acute asthma who were admitted and readmitted to the medical wards of public hospitals in Nekemte Town, South West Ethiopia, between August 25, 2021, and October 24, 2024.

#### 4.4. Eligibility Criteria

##### 4.4.1. Inclusion criteria for cases

Using the hospital admission data, we identified all adults (aged  $\geq 18 \leq 75$ ) readmitted with acute asthma within 90 days with a principal discharge diagnosis of acute asthma, as defined by the International Classification of Diseases, Eleventh Revision (ICD-11) diagnosis code CA23.xx. (13) from August 25, 2021, until October 24, 2024, in Public Hospitals in Nekemte Town, Ethiopia.

##### 4.4.2. Inclusion criteria for controls

Adult acute asthmatic patients admitted and including readmitted patients greater than 90 days after index admission (aged  $\geq 18 \leq 75$ ) with a principal discharge diagnosis code, as defined by the International Classification of Diseases, Eleventh Revision (ICD-11) CA23.xx from August 25, 2021, until October 24, 2024, in public hospitals Nekemte Town, Ethiopia.

##### 4.4.3. Exclusion criteria for cases

Readmitted patients diagnosed with acute asthma, along with additional diagnoses of Chronic Obstructive Pulmonary Disease (COPD), pulmonary tuberculosis, and known heart failure, as well as patient charts lacking adequate information, such as unknown age, unknown sex, unknown date of index admission, and readmission, were excluded from the study. Patients with acute asthma who have additional diagnoses of COPD, tuberculosis, and heart failure have been excluded due to the similarities in signs and symptoms of these conditions with those of asthma, which may introduce potential bias. This exclusion aims to ensure that all readmitted acute asthma patients are attributed solely to acute asthma.

##### 4.4.4. Exclusion criteria for controls

Patients who were admitted and subsequently readmitted for acute asthma more than 90 days following their initial discharge, along with those presenting comorbidities such as Chronic Obstructive Pulmonary Disease (COPD), pulmonary tuberculosis, and confirmed heart failure, were excluded from the study. Furthermore, patient records that were deficient in adequate information (including unknown age, unknown sex, and unknown date of initial admission), individuals who departed against medical advice, as well as patients who were referred from and transferred to other healthcare facilities, were likewise omitted. Patients diagnosed with acute asthma, in conjunction with additional diagnoses of COPD, tuberculosis, and heart failure, were excluded due to the overlapping signs and symptoms

of these conditions with those of asthma, which may potentially introduce bias and obscure the accurate assessment of all patients admitted specifically for acute asthma.

#### 4.5. Sample Size Determination

The sample size of the study participants was determined by factors related to acute asthma readmission. The sample size was calculated using EpiInfo Version 7.2.6.0 and a two-population distribution formula with a 95% confidence interval (CI) power of 80%, a case-to-control ratio of 1:2, and a significance level of 5%. The final sample size was determined by selecting middle-aged adults (40-64) as a risk factor. Similarly, the percentage of older adults among cases (P1) and exposed controls (P2) is 71.1% and 55%, respectively, using the AOR of 2.05 from the previous study (58). The sample size was determined using an adjusted odds ratio (AOR). The required sample size is 327, 109 cases and 218 controls. To address the non-response rate, 5 percent was added, resulting in a final sample size of 343 participants, 114 cases, and 229 controls.

Table 1: Summary of sample size calculation table on determinants of readmission for acute asthma

| Variables                                   | Proportions                   | Sample Size |          |       | Adding 5% for the non-response rate       |
|---------------------------------------------|-------------------------------|-------------|----------|-------|-------------------------------------------|
|                                             |                               | Cases       | Controls | Total |                                           |
| Age $\geq 40$ - $\leq 65$                   | P1 = 71% P2 = 55% AOR = 2.05  | 109         | 218      | 327   | 114 cases and 229 controls, Total 343     |
| Histories of the previous year's admissions | P1 = 50.1% P2 = 33% AOR= 2.04 | 106         | 210      | 316   | 112 cases & 221 controls, 333 total       |
| ICU admission                               | P1 = 40% P2 = 17% AOR= 3.72   | 40          | 80       | 120   | 42 cases & 84 controls 126 Total          |
| Longer oxygen therapy ( $\geq 16$ hrs.)     | P1 = 82% P2 = 48% AOR = 4.9   | 28          | 55       | 83    | 29 cases & 59 controls of 88              |
| ED visits                                   | P1 = 18% P2 = 6% AOR = 3.55   | 89          | 178      | 267   | 94 cases and 187 controls, a total of 281 |

Where: -P1= percent of cases exposed; P2 percent of controls exposed; AOR adjusted odds ratio

#### 4.6. Sampling Technique

The research information was obtained from public hospitals found in Nekemte Town. A total of 487 patients, presenting with acute asthma episodes, were readmitted and admitted to the medical wards of public hospitals. Proportionate number of study participants were taken from each hospital using the formula  $= (n) \times (nf) / N$  where  $n$  = the number of readmitted acute asthma patients in less than 90 days of index discharge in respective hospital,  $n1$  = the number of admitted and including readmitted acute asthma patients greater than 90 days of index discharge in respective hospital,  $nf$  = total sample size for cases,  $nf1$  = total sample size for controls and  $N$  = the total number of admitted and readmitted acute asthmatic patients in the two Hospitals. The distribution was allocated proportionally to the two hospitals. The consecutive sampling method was used until the required number of study participants was obtained from both facilities. During the study, 220 control and 110 case charts were selected using consecutive sampling.

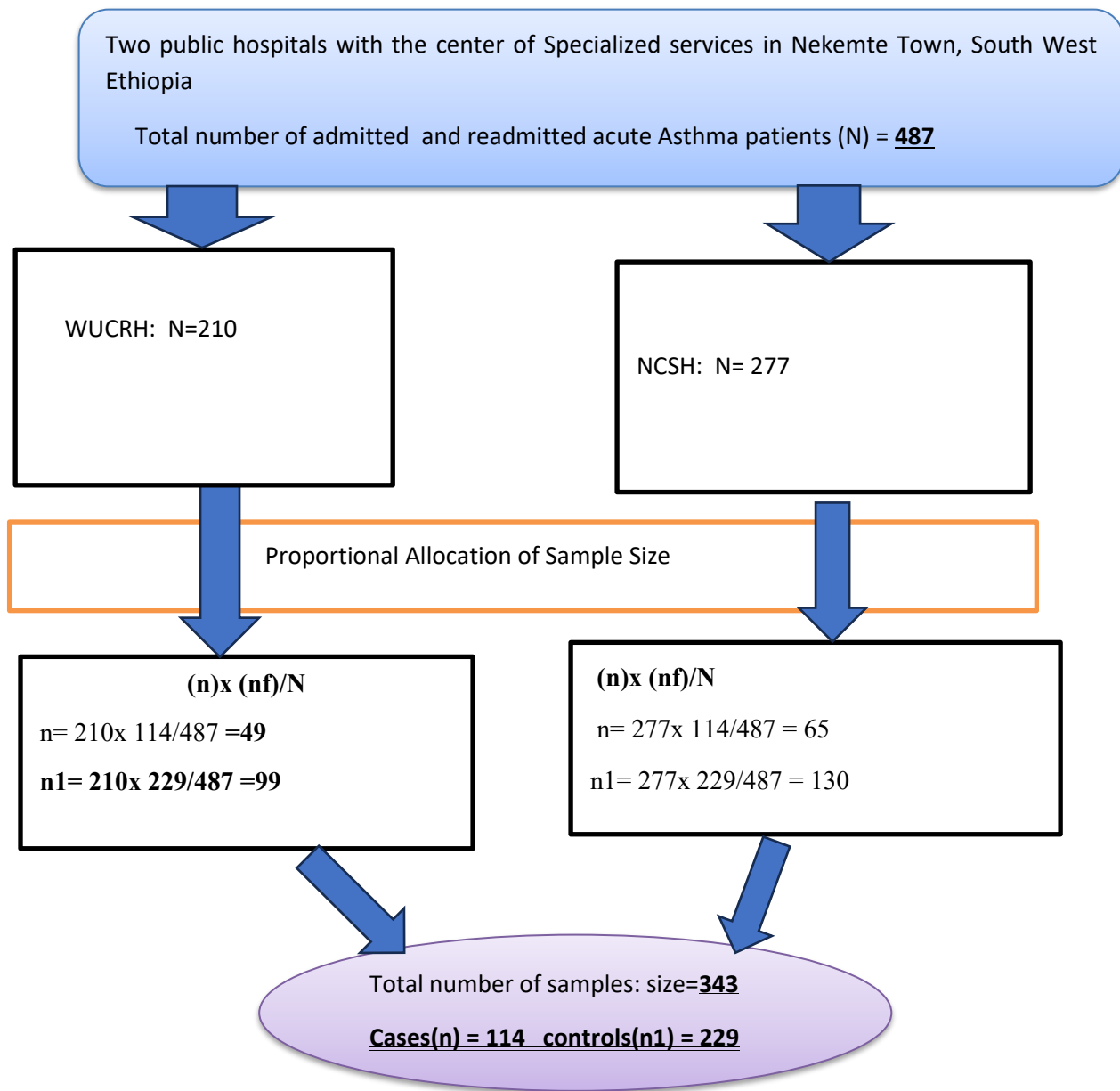


Figure 2: Schematic Presentation of Sampling techniques used to select participants from Public Hospitals in Nekemte Town in South West Ethiopia.

## 4.7. Variables of the Study

### 4.7.1. Dependent variable

Readmission for Acute asthma within 90 days of their index admission.

### 4.7.2. Independent variables

Several demographic characteristics of patients diagnosed with acute asthma were examined, including age, gender, residence, and participation in community-based health insurance programs. The environmental variable was extracted from the date of the index admission. A range of baseline and disease status-indicating variables was analyzed to clarify the medical complexities of our comparison groups. The history of unexpected visits to the emergency department, hospital admissions, scheduled hospital visits, intensive care unit admissions within the previous year, and chronic use of oral corticosteroids was assessed based on their established correlations with readmissions among hospitalized individuals.

The factors related to healthcare that were assessed include laboratory biomarker results, the presence of active infections, the quality of care provided, and the effectiveness of the discharge plan. Laboratory biomarkers, with particular emphasis on eosinophil count, are regarded for their correlation with readmissions among recently hospitalized patients. The quality and adequacy of treatment during the index admission are pivotal in minimizing early readmissions for acute asthma. Following the recommendations provided by GINA regarding the treatment of acute asthma, we extracted the following data during the index admission: status of oxygen usage, presence of active airway infection with corresponding treatment, administration of short-acting beta-agonists (SABA), and the use of systemic corticosteroids. Moreover, the implementation of adequate and appropriate treatment for acute asthma, coupled with a robust discharge strategy, can avert late readmissions associated with asthma. Furthermore, the completeness and effectiveness of the discharge plan were evaluated against several criteria, which include the ordering of reliever medications, the prescription of controller medications such as inhaled corticosteroids (ICS) and oral corticosteroids (OCS) at the time of discharge from the hospital, as well as the scheduling of post-discharge care and appropriate education regarding inhaler use.

## 4.8. Data Collection Tool

We systematically extracted data for key variables, informed by existing literature on readmission for acute asthma and the availability and reliability of information within the

medical chart. Content validity is determined based on the judgment of a panel of professionals and field experts, who are asked to evaluate the level of importance of the items on the instrument. A three-point scale is utilized for each item, which is categorized as follows: Essential (very important), Useful but not essential, and Not necessary. The total number of experts engaged for content validity is seven, who have been identified and invited to examine the research instrument. The principal guidelines utilized in the selection of experts are as follows: emergency medicine specialists, general practitioners, and internists from clinical practice, all possessing a minimum of three years of experience in referral or specialized hospitals, along with researchers with related topics and academic experts with skills in relevant domains and thematic concepts based on their career experiences. Furthermore, reviewers are also required to identify areas of deficiency and provide suggestions and recommendations on enhancing the clarity and brevity of the instrument's items. Accordingly, the importance of the items on the instrument is determined by the Content Validity Ratio (CVR), with items that achieve a score above 0.5 being retained in the instrument. Subsequently, after the removal of four variables—namely, ethnicity, education level, LABA, and comorbid disease—due to the unavailability of data in the patient charts, additional variables including NSAIDs, beta-blocker drugs, and two others were eliminated based on their content validity ratio scores. Ultimately, the content validity of the instrument is approved using the content validity index value, which reflects the level of agreement among the seven experts, calculated as 0.853. Additionally, a pretest is conducted with 5% of the total sample in the study setting. The tool demonstrates reliability, with a Cronbach's alpha of 0.80, signifying acceptable reliability. The data abstraction checklist emphasizes socio-demographic, environmental, clinical, and healthcare-related factors associated with acute asthma. The demographic section comprises four items, each offering two options. The ecological section consists of one item with four available options. The clinical section includes eight items, each providing two to five options. The healthcare-related section comprises twenty-four items, each with two to four options. Finally, a trained data abstractor is responsible for collecting the information from the selected hospitals.

#### 4.9. Data Collection Procedure

The data were collected from the patient chart using an extraction checklist. To strengthen the data collection efforts, recruited two BSc nurses to assist with data collection and two senior nurses who hold key supervisory roles. This dedicated team is committed to

thorough and systematic data collection and analysis. The study participants were identified through the medical ward admission register. The Medical Record Number of study participants was selected from the hospital admission registers of the relevant wards to collect data on controls and cases. The study participants were classified as cases or controls based on the number of visits recorded on the summary sheet. Cases were defined as individuals readmitted within 90 days of hospital discharge with the same diagnosis of index discharge; otherwise, they were categorized as controls. The data abstraction checklist was completed using the guidance document to ensure consistency.

#### 4.10. Data Quality Control and Assurance

The principal investigator ensured the quality of the data by providing comprehensive training to the data collectors and meticulously reviewing the checklist for accuracy in the data abstraction process. To enhance consistency in data abstraction, we developed a detailed manual about the items on the data abstraction checklist. Upon the completion of the data abstraction process, a meeting is convened with the controller to discuss and elucidate any issues that may arise during the encoding process. This study examines challenges in data collection and verifies that data collectors complete the checklist accurately and consistently for subsequent review. The finalized abstraction checklist has been thoroughly appraised for consistency, accuracy, and potential gaps. Additionally, before the commencement of data collection, the collectors engaged in the coding of five patient records for practice purposes. This pretest was executed within a comparable hospital environment, and modifications were implemented to the study abstraction checklist accordingly.

#### 4.11. Data processing and statistical analysis

The data was entered using EPI Data Manager version 4.6.0.2, which included editing, cleaning, coding, and verifying completeness and consistency. The data was analyzed using the SPSS 26 Windows version. Continuous variables were presented as mean and standard deviation, while categorical variables were presented as frequencies and percentages. Logistic regression analysis was used to assess the determinants of acute asthma readmissions. Adjusted Odds ratios and 95% CI were used to determine the strength of association. Bivariate logistic regression analysis was computed to identify multivariable logistic regression analysis candidates. Variables with a p-value less than 0.25 on the bivariable logistic regression model were candidate variables to be considered in the multivariable logistic regression model to determine the determinants of re-admission

within 90 days among adult asthma patients. The model's goodness was assessed using the Hosmer and Lemeshow test. The results of the multivariable logistic regression analysis were presented using an Adjusted Odds Ratio (AOR) with a corresponding 95% confidence interval (CI), and statistical significance was declared at a p-value of  $< 0.05$ .

#### 4.12. Ethical considerations

Ethical approval was secured from the Research Ethics Review Committee of Wollega University (WUIHSRERC), and a formal collaboration letter was obtained, bearing the reference number IHSREC/007/057/2025, which was subsequently presented to the pertinent public hospitals. Prior to the initiation of the study within the medical ward, we acquired enthusiastic endorsement from the Chief Executive Officers of each respective hospital, thereby ensuring their comprehensive support and collaboration. The anonymity of patients was upheld by concealing the patient's name and other personal information in all reports. The collected data were maintained in strict confidentiality, limited to the research team.

#### 4.13. Plan for dissemination of results

The research report will be presented at Wollega University. The study's findings will be submitted for publication in peer-reviewed journals. The research report will be distributed to relevant bodies, including the University of Wollega and the Nekemte Town Public Hospitals.

#### 4.14. Operational Definitions:

**Acute Asthma:** Individuals who presented with wheezing, cough, dyspnea, and chest tightness were diagnosed by asthma physicians with any phenotype of asthma disease (75).

**Ninety-Day Acute Asthma Readmission:** A hospital readmission occurring within 90 days after a patient was discharged from the hospital for the index admission(76).

**Asthma control:** The state of asthma symptoms, reduced or prevented respiratory manifestations by treatment (77).

**Asthma trigger:** A factor that may worsen asthma or a stimulus that causes asthma symptoms by narrowing the airways, such as dust mites, cockroaches, pollen, respiratory viruses, smoke, or asthma triggers caused by medicines. These factors are directly related to the onset of acute asthma attacks (78).

**Corticosteroids:** Natural and synthetic analogs of hormones produced by the anterior hypothalamus, Adrenocorticotrophic pituitary axis, or pituitary gland, including glucocorticoids, which have potent anti-inflammatory properties (77).

**Early acute asthma readmission:** Readmission with acute asthma occurs within 30 days of a previous admission in the study setting (43).

**Hospital discharge:** When the acute asthma patient is officially released, this is usually when hospitalized patients are discharged, and transaction volumes are calculated (79).

**Index Admission:** During the study period, acute asthma episodes were initially admitted to the study setting (76).

**Late acute asthma readmission:** Acute asthma readmission occurs 30 to 365 days after index admission (49).

**Length of stay (LOS):** We calculated the length of stay for the index admission as the number of days from the hospital admission date to the discharge date. An acute asthma admission on the same day will be considered one day (80).

**Long-term oxygen therapy:** Acute asthma patients received supplemental oxygen support for more than or equal to 16 hours per day for multiple days (81).

## 5. RESULTS

### 5.1. Sociodemographic Characteristics of Participants

A total of 330 participants (110 cases and 220 controls), who visited two selected public hospitals in Nekemte Town (WUCSH and NHCSH), were involved, after excluding incomplete patient charts with unknown age, sex, and date of index admission, with a chart availability and completeness rate of 96%. The mean age of the study participants among cases was 50( $\pm$ SD 8) and 43( $\pm$ SD 10) for controls. Most of the study participants among cases (85%) and two-thirds of the controls (65%) were in the 40-64 age group. More than half of the study participants were female among cases (54.4%) and 59% of controls. Nearly half of the cases (46.4%) and more than half of the controls (51.8%) reside in urban areas. The study participants' community health insurance membership status: 45.5% of the cases and 54.5% of the controls had enrolled in community health insurance (Table 2).

*Table 2: Demographic characteristics of study participants at public hospitals in Nekemte town, South West Ethiopia*

| Variables          | Category | Cases<br>(n=110) | Controls<br>(n=220) | Total (n=330) |
|--------------------|----------|------------------|---------------------|---------------|
|                    |          | N (%)            | N (%)               | N (%)         |
| Age Category       | 18-39    | 7(6.4%)          | 61(28%)             | 68(21%)       |
|                    | 40-64    | 94(85.5%)        | 144(65%)            | 238(72%)      |
|                    | 65-75    | 9(8.2%)          | 15(7%)              | 24(7%)        |
| Sex of Participant | Male     | 50(45.5%)        | 90(40.9%)           | 140(42.4%)    |
|                    | Female   | 60(54.5%)        | 130(59.1%)          | 190(57.6%)    |
| CBHI Membership    | Yes      | 50(45.5%)        | 120(54.5%)          | 170(51.5%)    |
|                    | No       | 60(54.5%)        | 100(45.5%)          | 160(48.5%)    |
| Place of Residence | Urban    | 51(46.4%)        | 114(51.8%)          | 165(50%)      |
|                    | Rural    | 59(53.6%)        | 106(58.2%)          | 165(50%)      |

### 5.2. Clinical Characteristics of Participants

The mean duration of stay with asthma since diagnosis among controls was 7 $\pm$ 3 years, and for cases, 9 $\pm$ 3 years. Two-thirds of study participants in the control (65%) and case (66%) groups made scheduled visits. The mean number of last year's scheduled hospital visits among controls was 4 and 3 for cases. More than a third of the controls (34%) and more than half of the cases (54%) had a history of emergency department visits in the previous

year. About three-fourths of the cases (73.6%) and nearly half of the controls (49.5%) had a history of hospitalization in the past year, before initial admission. The mean history of previous year admission among controls was one, and the cases were two. Half of the cases (50%) and 38% of controls had a history of past-year ICU admission. More than a third of controls (34%) and nearly half of cases (49%) had a history of chronic use of oral corticosteroid drugs (Table 3).

Table 3: The clinical characteristics of study participants at Public hospitals in Nekemte town, South West Ethiopia

| Variables                                      | Category | Cases (n=110) | Control (n=220) | Total (n=330) |
|------------------------------------------------|----------|---------------|-----------------|---------------|
|                                                |          | N (%)         | N(%)            | N(%)          |
| Asthma Duration                                | 1-10     | 65(59.1%)     | 174(79.1%)      | 239(72.4%)    |
|                                                | 11-20    | 45(40.9%)     | 46(20.9%)       | 91(27.6%)     |
| Scheduled visits                               | Yes      | 73(66.4%)     | 143(65%)        | 216(65.5%)    |
|                                                | No       | 37(33.6%)     | 77(35%)         | 114(34.5%)    |
| ED visits in the previous year                 | Yes      | 60(54.5%)     | 75(34.1%)       | 135(40.9%)    |
|                                                | No       | 50(45.5%)     | 145(65.9%)      | 195(59.1%)    |
| Hospitalizations                               | Yes      | 81(73.6%)     | 109(49.5%)      | 190(57.5%)    |
|                                                | No       | 29(26.4%)     | 111(50.5%)      | 140(42.5%)    |
| Previous History of ICU Admission              | Yes      | 55(50.0%)     | 85(38.6%)       | 140(42.4%)    |
|                                                | No       | 55(50.0%)     | 135(61.4%)      | 190(57.6%)    |
| History of chronic use of oral corticosteroids | Yes      | 54(49.1%)     | 75(34.1%)       | 129(39.1%)    |
|                                                | No       | 56(50.9%)     | 145(65.9%)      | 201(60.9%)    |

### 5.3. Healthcare-Related Characteristics of the Study Participant

The mean eosinophilic count among control subjects was 2.17, compared to 3 for the cases. More than half (55%) of the cases and nearly two-thirds (63.6%) of the controls were diagnosed with upper respiratory tract infections (URTI) during the initial admission. Of these patients, 57% of the controls were treated with azithromycin, while 59% of the URTI cases received ceftriaxone. Three-fourths (74.5%) of both the cases and controls utilized reliever medication during the initial admission. All cases (100%) and controls (100%) were administered salbutamol as rescue medication. The majority of study participants

received systemic corticosteroids during the initial admission, and all participants were administered hydrocortisone for the acute episode. Nearly three-fourths of the cases (75%) and controls (74%) received rescue medication upon discharge. Similarly, three-fourths (73.6%) of both the control and case groups were discharged with inhaled corticosteroids (ICS) at the time of discharge. All participants received beclomethasone as a controller medication upon discharge during the initial admission. Over a third of the controls (40%) and 57% of the cases received oral medication during the separation of care on their initial admission. Among these participants receiving oral medication, more than half of the cases (52%) were treated with prednisolone, while 55% of the control group received theophylline upon discharge. The average length of stay during the initial admission was three days for the controls and four days for the cases. A quarter of the control group (23%) and nearly one-fifth of the cases (16%) were admitted to the intensive care unit (ICU) during their initial admission. More than half of the cases (60%) and 54% of the controls were scheduled for post-discharge visits. Among those scheduled for follow-up, the majority of controls (80%) and 55% of the cases were slated for routine visits 30 days post-discharge (Table 4).

Table 4 Healthcare Related Characteristics of the Study Participant at public hospitals, Nekemte town, South West Ethiopia

| Variables                                     | Category       | Cases (n= 110) | Controls(n= 220) | Total      |
|-----------------------------------------------|----------------|----------------|------------------|------------|
|                                               |                | N(%)           | N(%)             | N(%)       |
| URTI                                          | Yes            | 61(55.5%)      | 140(63.6%)       | 201(60.9%) |
|                                               | No             | 49(44.5%)      | 80(36.4%)        | 129(39.1%) |
| Antibiotics used                              | Ceftriaxone    | 36(59%)        | 61(43%)          | 97(48%)    |
|                                               | Azithromycin   | 25(41%)        | 79(57%)          | 104(52%)   |
| SABA during the index admission               | Yes            | 82(74.5%)      | 165(75%)         | 247(74.8%) |
|                                               | No             | 28(25.5%)      | 55(25%)          | 83(21.2%)  |
| Specific SABA drugs used                      | Salbutamol     | 82(100%)       | 165(100%)        | 247(100%)  |
| Systemic corticosteroid at index admission    | Yes            | 86(78.2%)      | 165(75%)         | 251(76.1%) |
|                                               | No             | 24(21.8%)      | 55(25%)          | 79(23.9%)  |
| Rescue medication on discharge                | Yes            | 82(74.5%)      | 162(73.6%)       | 244(73.9%) |
|                                               | No             | 28(25.5%)      | 58(26.4%)        | 86(26.1%)  |
| controller treatment on discharge             | Yes            | 81(73.6%)      | 162(73.6%)       | 243(73.6%) |
|                                               | No             | 29(26.4%)      | 58(26.4%)        | 87(26.4%)  |
| Specific controller drug                      | Beclomethasone | 81(100%)       | 162(100%)        | 243(100%)  |
| Oral medication on discharge                  | Yes            | 63(57.3%)      | 88(40%)          | 151(45.8%) |
|                                               | No             | 47(42.7%)      | 132(60%)         | 179(54.2%) |
| Specific oral medication prescribed           | Prednisolone   | 35(55%)        | 39(44%)          | 74(49%)    |
|                                               | Theophylline   | 28(45%)        | 49(56%)          | 77(51%)    |
| ICU during the index admission                | Yes            | 18(16.4%)      | 50(22.7%)        | 68(20.6%)  |
|                                               | No             | 92(83.6%)      | 170(77.3%)       | 262(79.4%) |
| Appointment scheduled for a post-discharge    | Yes            | 66(60%)        | 119(54.1%)       | 185(56.1%) |
|                                               | No             | 44(40%)        | 101(45.9%)       | 145(43.9%) |
| Specify the interval set for scheduled visits | Within 7 days  | 4(3.6%)        | 0                | 4(2%)      |
|                                               | Within 14 days | 17(15.5%)      | 25(11.4%)        | 42(23%)    |
|                                               | Within 30 days | 36(32.7%)      | 94(42.7%)        | 130(70%)   |
|                                               | Within 90 days | 9(8.2%)        | 0                | 9(5%)      |
| Hospital Stay                                 | 1-3            | 31(28.2%)      | 133(60.5%)       | 164(49.7%) |
|                                               | 4-6            | 79(71.8%)      | 87(39.5%)        | 166(50.3%) |

#### 5.4. Determinant Factors of Late Readmission for Acute Asthma

In the bivariable analysis, twenty variables were included, of which eleven were candidates for multivariate analysis with a cut-off p-value of 0.25. Accordingly, the results of the bivariate analyses indicated that middle-aged adults (COR = 5.6, 95% CI = 2.4, 12.9), CBHI (COR = 1.4, 95% CI = 0.9-2.2), OCS use during the index hospital admission and discharge (COR = 2.0, 95% CI = 1.28-3.2), history of ICU admission (COR = 1.5, 95% CI = 1-2.5), previous year unexpected ED visits (COR = 2.32, 95% CI = 1.45-3.7), history of hospitalization in the last year (COR = 2.8, 95% CI = 1.72-4.68), URTI (COR = 1.4, 95% CI = 0.8-2.2), hospital length of stay during index admission (COR = 3.8, 95% CI = 2.3-6.27), years since asthma diagnosis (COR = 2.6, 95% CI = 1.6-4.4), higher eosinophil count (COR = 3.6, 95% CI = 2.56-5.08), and ICU stay during the index admission (COR = 1.5, 95% CI = 0.8-2.7) were associated with readmission for acute asthma. These variables were employed in the multivariable analyses. In the multivariable logistic regression analysis, six variables: age category, history of ED visits, history of admissions in the previous year, high eosinophil count, prolonged hospital stay during index admission, and extended duration of asthma, remained statistically significant concerning readmission for acute asthma at a p-value of 0.05. When compared with younger adults, middle-aged adults exhibited a 3.3 times higher likelihood of readmission for acute asthma (AOR = 3.3, 95% CI = 1.3–8.6). Similarly, patients with unplanned ED visits in the prior year (AOR = 2.2, 95% CI = 1.2, 3.9) and those requiring hospitalization were two times more likely to be readmitted for acute asthma (AOR = 2.4, 95% CI = 1.3, 4.4). Furthermore, an asthma diagnosis lasting more than ten years increased the odds of readmission for acute asthma by a factor of 2.4 compared to those with a duration of less than ten years (AOR = 2.4, 95% CI = 1.3, 4.4). Moreover, patients who experienced a hospital stay during the index admission of four to six days had a 2.4 times greater likelihood of readmission than those with a one to three-day hospital stay (AOR = 2.4, 95% CI = 1.3, 4.3). Additionally, patients presenting with a 1% increase in eosinophil count from total WBC were 2.6 times more likely to be readmitted for acute asthma (AOR = 2.6, 95% CI = 1.8-3.8) (Table 5).

Table 5: Factors Associated with Late Readmission for Acute Asthma at Public Hospitals in Nekemte Town, South West Ethiopia

| Variables                        | Category | (Cases =110) | (Controls = 220) | COR (95% CI)  | AOR (95% CI)   | P Value  |
|----------------------------------|----------|--------------|------------------|---------------|----------------|----------|
|                                  |          |              |                  |               |                |          |
| Last Year, ED Visits             | Yes      | 60(54%)      | 75(34%)          | 2.3(1.4-3.7)  | 2.2(1.2, 3.9)  | 0.007*   |
|                                  | No       | 50(46%)      | 145(66%)         |               |                |          |
| History of Hospitalizations      | Yes      | 81(74%)      | 109(49%)         | 2.8(1.7-4.4)  | 2.4(1.3, 4.4)  | 0.004*   |
|                                  | No       | 29(26%)      | 111(51%)         |               |                |          |
| Eosinophil Count                 | Mean     | 2.98         | 2.17             | 3.6(2.5-5.0)  | 2.6(1.8, 3.8)  | <0.001** |
| Asthma Duration                  | 11-20    | 45(59%)      | 46(80%)          | 2.6(1.6-4.4)  | 2.4(1.3, 4.4)  | 0.005*   |
|                                  | 1-10     | 65(41%)      | 174(20%)         |               |                |          |
| Hospital Stay                    | 4-6      | 79(72%)      | 87(40%)          | 3.8(2.3-6.2)  | 2.4(1.3, 4.3)  | 0.004*   |
|                                  | 1-3      | 31(28%)      | 133(60%)         |               |                |          |
| Age Category                     | 40-64    | 94(85.5%)    | 144(65%)         | 5.6(2.4,12.9) | 3.3(1.3, 8.6)  | 0.011*   |
|                                  | 65-75    | 9(8.2%)      | 15(7%)           | 5.2(1.6,16.3) | 2.9(0.8,10.53) | 0.1      |
|                                  | 18-39    | 7(6.4%)      | 61(28%)          |               |                |          |
| Oral medication use on Discharge | Yes      | 63(57.2%)    | 88(40%)          | 2.0(1.2-3.2)  | 1.4(0.8, 2.5)  | 0.239    |
|                                  | No       | 47(42.7%)    | 132(60%)         |               |                |          |

\*Statistically significant \*\* highly statistically significant

## 6. DISCUSSION

This study aimed to identify the determinants of readmission for acute asthma in public hospitals. This study is one of the few studies that attempted to identify determinants of readmission for acute asthma, defined as a readmission within 90 days of discharge among adults. This study found that being older, the previous year's unexpected ED visit, last year's hospitalization, a high eosinophil count, longer hospital stays, and longer asthma life were significantly associated with readmission for acute asthma. The study results showed that the determinants of readmission for acute asthma reside around demographic, clinical, and healthcare factors. However, the clinical factors were due to individual rather than healthcare-level factors.

The study findings indicate that last year's hospital admission was a strong indicator for acute asthma readmission. Similarly, a prior study found that last year's hospitalization for acute asthma was identified as the most important indicator of readmission for acute asthma (58). This study's findings align with prior USA(82) and Ethiopia(16) studies, supporting that the history of last year's hospitalization was significantly associated with readmission for acute asthma. The history of previous year hospitalization indicates baseline asthma severity and suboptimal control of asthma symptoms. (46). This might be due to a failure to achieve optimal asthma symptom control.

The study findings also showed that previous ED visits were associated with a higher probability of readmissions for acute asthma. Consistently, one study in the US reported that ED visits in the last 12 months were the most valid and reliable marker for the probability of acute asthma readmission (82). This difference is multifactorial, such as access to improved outpatient services, adherence to controller medication use, adequate dose, and correct use of inhaler drugs. Importantly, this study's results revealed that last year's ED visits are a strong determinant factor in subsequent acute asthma readmissions.

In this study, findings revealed that, in comparison with younger adults, middle-aged adults had 3 times higher odds of 90-day readmission for acute asthma. Consistent with previous studies in the USA (29, 45, 55), this study revealed that a middle-aged adult had a higher proportion of readmissions for acute asthma. Reasons for adults' 90-day readmission are diverse, and contributions are from patient complexity, asthma symptom control efficacy, and health service factors. In summary, the odds of higher readmission among aged adults may be associated with decreased responsiveness to drug treatment due to airway

remodeling that has changed over time (3), years since asthma diagnosis, loss of physical activity, and physiologic decline of lung function, explained by aging.

No studies have addressed prolonging hospital stay as a strategy to reduce readmissions. Furthermore, data from the current study and many previous reports indicated that longer hospital stay is an important determinant factor for readmission(47-49). A recent study examined the preventability of hospital readmissions and identified strategies to reduce future occurrences. According to the perspectives of hospitalists, approximately 15% of readmissions could have been avoided (83). Additionally, in nearly 23% of cases, extending a patient's length of stay by one or two days could have prevented a readmission(83). This reflects a fundamental conflict in our daily work: balancing the need for available beds for new admissions with the necessity of keeping patients long enough to prevent readmission. In sum, higher readmission rates in longer lengths of stay may be attributed to the severity or complexity of the basic chronic illnesses, baseline asthma severity, and/or reduced compliance with treatment due to aging (3).

In this study, a high eosinophil count is associated with readmission for asthma. Consistent with this study, previous studies in the UK(67) and Finland(70) reported that high eosinophil count is associated with acute asthma readmission. These associations might be related to discharge decisions made by the least experienced staff members, baseline uncontrolled asthma attributed to poor drug adherence, and inaccessibility of improved asthma care.

Ultimately, the determinants affecting 90-day readmission rates for acute asthma in our study area align with findings from prior research; however, certain factors may be unique to this study region. In conclusion, the clinical and healthcare determinants associated with acute asthma readmissions present a prospective target for interventions aimed at reducing avoidable readmissions.

### 6.1. Strengths and Limitations of the Study

The robustness of this study is attributed to its sufficiently adequate sample size and the mitigation of potential biases arising from the introduction of comorbidities in conjunction with asthma symptoms. However, a primary limitation of the study is that, due to the nature of the secondary data employed, it is precluded from acquiring information on medication adherence and the baseline asthma severity index, as defined by the Global Initiative for Asthma (GINA). Moreover, the intentional selection of study settings may have implications for the representativeness of the findings.

## 7. CONCLUSION AND RECOMMENDATION

### 7.1. Conclusion

This study examines the factors contributing to the readmission of patients with acute asthma. Key characteristics include advanced age, previous instances of emergency department visits, past hospital admissions, prolonged duration of asthma, and extended hospital stays in the year preceding an asthma-related hospitalization. The findings indicate that asthma patients who are older at the time of admission, have experienced emergency department visits in the past year, have had hospital admissions in the prior year, and possess a lengthy history of asthma require diligent follow-up and optimized treatment following discharge. Furthermore, it is essential to assess patients who experienced extended hospital stays and exhibited elevated eosinophil counts during their initial admission to implement interventions aimed at reducing asthma-related readmissions in the subsequent year.

### 7.2. Recommendation

#### Hospital Manager

Hospital administrators are expected to ensure compliance with established treatment protocols for acute asthma exacerbations, particularly for patients with a history of previous emergency department visits, hospital admissions within the past year, chronic asthma, prolonged hospitalizations, elevated eosinophil counts, and advanced age. This strategy aims to reduce the rate of readmission for acute asthma following patient discharge.

#### Health Care Worker

Clinicians responsible for the management of patients with acute asthma, particularly those with a history of prior emergency department visits, hospital admissions, advanced age, prolonged duration of asthma, and elevated eosinophil count, should prioritize comprehensive evaluation, effective control of acute asthma exacerbations, and the implementation of complete asthma discharge bundles to mitigate asthma-related readmissions.

#### Researchers

Furthermore, deep exploration is necessary for each associated factor with acute asthma readmission. In addition, random selection of the study setting and participants is key for minimizing possible selection bias.

### Patients

Patients with asthma who have a history of previous admissions, unexpected visits to the emergency department, advanced age, and prolonged duration of asthma should aim to attain optimal control of asthma symptoms. This effort is essential for minimizing potential asthma-related admissions, which may lead to unfavorable health outcomes and increased healthcare costs.

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## 9. APPENDIX 1

### Information sheet

**Name of the investigator:** MOHAMMED NESRU (BSC, MSC candidate)

**Research Title:** Determinants of Readmission for Acute Asthma in Public Hospitals in Nekemte Town, Ethiopia, 2025.

**Research Objective:** To identify the demographic, clinical, and Healthcare-associated factors with Acute Asthma Readmission in public Hospitals in Nekemte Town, Ethiopia, 2025

**Study Procedure:** To achieve the study's objectives, demographic, clinical, and health-related factors were collected from patient charts using a structured questionnaire and a guidance manual.

**Confidentiality:** The collected information was kept confidential and used only for research purposes. No one except research team members will have access to the information gathered.

**Person to Contact:** If the data collectors or other hospital administrative staff have any queries regarding this study, they are free to contact me in person or by the following address:

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## APPENDIX 2

### WOLLEGA UNIVERSITY COLLEGE OF HEALTH SCIENCE AND DEPARTMENT OF ADULT HEALTH NURSING

A Questionnaire was prepared to Collect Data on the Determinants of Readmission for Acute Asthma Among adult patients in Public Hospitals in Nekemte Town, Ethiopia.

| <b>Part1: Sociodemographic Characteristics</b> |                                                                                            |                                                  |               |
|------------------------------------------------|--------------------------------------------------------------------------------------------|--------------------------------------------------|---------------|
| <b>S/No.</b>                                   | <b>Variables</b>                                                                           | <b>Category</b>                                  | <b>Remark</b> |
| 1                                              | Is an acute asthma patient readmitted within 90 days of the index admission and discharge? | 1. Readmitted 0. Not readmitted                  |               |
| 2                                              | If yes to question number one, specify the date of readmission (MM/DD/YY)                  | Date:                                            |               |
| 3                                              | Age                                                                                        | _____ years                                      |               |
| 4                                              | Gender                                                                                     | 1. Male<br>2. Female                             |               |
| 5                                              | Is the acute asthmatic patient enrolled in CBHI membership?                                | 1. CBHI member<br>2. Self-pay                    |               |
| 6                                              | Residence                                                                                  | 1. Urban<br>2. Rural                             |               |
| <b>Part 2: Environmental Factor</b>            |                                                                                            |                                                  |               |
| 7                                              | Season of index admission                                                                  | 1. Winter<br>2. Spring<br>3. Summer<br>4. Autumn |               |

|                                |                                                                                                                                           |                                                            |           |
|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|-----------|
| <b>Part 3: Clinical Factor</b> |                                                                                                                                           |                                                            |           |
| 8                              | Duration of stay in a year after diagnosis                                                                                                | Years _____                                                |           |
| 9                              | Does the asthma patient make scheduled visits? ((if yes go to next question; if no skip to Question 11)                                   | 1. Made scheduled visits,<br>2. Not made a scheduled visit |           |
| 10                             | Number of scheduled visits for asthma in the previous years                                                                               | _____                                                      | In number |
| 11                             | Did the patient make ED visits the previous year?                                                                                         | 1. ED visited<br>2. ED not visited                         |           |
| 12                             | History of previous year's hospitalizations due to acute asthmatic exacerbation (if yes, go to next question; if no, skip to Question 14) | 1. Admitted<br>2. Not Admitted                             |           |
| 13                             | If yes to question number 12, specify the number of admissions                                                                            | _____                                                      |           |
| 14                             | History of previous year ICU admission.                                                                                                   | 1. Admitted to ICU,<br>2. Not admitted to the ICU          |           |
| 15                             | History of chronic use of oral corticosteroids.                                                                                           | 1. Yes<br>2. No                                            |           |

| Part 4: Hospital-Related Factor |                                                                                                                            |                                      |        |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------------|--------------------------------------|--------|
| S/No.                           | Variables                                                                                                                  | Category                             | Remark |
| 16                              | Date of index admission                                                                                                    | Date: _____                          |        |
| 17                              | ICD-11 Diagnosis of index admission and discharge                                                                          | 1. CA23.30<br>2. CA23.2<br>3. CA23.0 |        |
| 18                              | Eosinophil count                                                                                                           | _____ -                              |        |
| 19                              | Pulse oximetry oxygen saturation measurement                                                                               | _____                                |        |
| 20                              | Does the patient use supplemental oxygen on index admission? (If yes, go to the next question; if no, skip to Question 22) | 1. Yes<br>2. No                      |        |
| 21                              | If yes, question number 20 specifies the duration of use in hours                                                          | _____                                |        |
| 22                              | Was the patient diagnosed with an acute upper respiratory tract infection at index admission? (If yes, go to the next      | 1. Yes<br>2. No                      |        |

|    |                                                                                                                                                    |                                                                                                                                      |  |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|--|
|    | question; if no, skip to Question 26)                                                                                                              |                                                                                                                                      |  |
| 23 | If yes, question number 22, specify the antibiotics used at index admission!                                                                       | <ol style="list-style-type: none"> <li>1. Ceftriaxone</li> <li>2. Azithromycin</li> <li>3. Amoxicillin</li> <li>4. Others</li> </ol> |  |
| 24 | Does the patient use a bronchodilator or SABA during index admission? (If yes, go to the next question; if no, skip to Question 26)                | <ol style="list-style-type: none"> <li>1. Yes</li> <li>2. No</li> </ol>                                                              |  |
| 25 | If yes, question number 24 specifies the drug used!                                                                                                | <ol style="list-style-type: none"> <li>1. Albuterol /Salbutamol</li> <li>2. Levalbuterol</li> <li>3. Others</li> </ol>               |  |
| 26 | Does the acute asthmatic patient receive systemic corticosteroid at index admission? (If yes, go to the next question; if no, skip to Question 28) | <ol style="list-style-type: none"> <li>1. Yes,</li> <li>2. No</li> </ol>                                                             |  |
| 27 | If yes to question number 26, which corticosteroid drug is used?                                                                                   | <ol style="list-style-type: none"> <li>1. Prednisolone</li> <li>2. Hydrocortisone</li> <li>3. Others</li> </ol>                      |  |
| 28 | Is the patient prescribed relief medication on hospital discharge?                                                                                 | <ol style="list-style-type: none"> <li>1. Yes,</li> <li>2. No</li> </ol>                                                             |  |

|    |                                                                                                                                                       |                                                              |  |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|--|
| 29 | Is any patient maintenance treatment medication (ICS) prescribed at hospital discharge? (If yes, go to the next question; if no, skip to Question 31) | 1. Yes,<br>2. No                                             |  |
| 30 | If yes to question number 29, specify the drug prescribed!                                                                                            | 1. Beclomethasone<br>2. Budesonide<br>3. Others specify----- |  |
| 31 | Does the acute asthmatic patient receive oral medication on hospital discharge? (If yes, go to the next question; if no, skip to Question 33)         | 1. Yes<br>2. No                                              |  |
| 32 | If yes to question number 31, specify the drug prescribed.                                                                                            | 1. Prednisolone<br>2. Theophylline<br>3. Other specify       |  |
| 33 | Does the patient receive education on appropriate inhaler technique use on discharge?                                                                 | 1. Yes<br>2. No                                              |  |
| 34 | Duration of stay in hospital during index admission specify                                                                                           |                                                              |  |

|    |                                                                                                                   |                                                                                                 |  |
|----|-------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|--|
| 35 | Does the patient stay in the ICU during the index admission?                                                      | 1. Yes,<br>2. No                                                                                |  |
| 36 | Is there any appointment scheduled for a post-discharge visit? (If yes, go to the next question; if no, complete) | 1. Yes,<br>2. No                                                                                |  |
| 37 | If yes to question 36, specify the interval set for scheduled visits!                                             | 1. From 1 to 7 days<br>2. From 8 to 14 days,<br>3. From 15 to 30 days,<br>4. From 31 to 90 days |  |

## APPENDIX 3

### Content Validity Reviewer Data Collection Form

Name \_\_\_\_\_ Gender \_\_\_\_\_ Date \_\_\_\_\_ Name of  
institution \_\_\_\_\_ Position \_\_\_\_\_ Work experience \_\_\_\_\_  
email address \_\_\_\_\_ Sign \_\_\_\_\_

| S.N | Variables                                                                                              | Scale                                                           |  |
|-----|--------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|--|
| 1   | Age                                                                                                    | 1. Necessary<br>2. Useful but not necessary<br>3. not necessary |  |
| 2   | Gender                                                                                                 | 1. Necessary<br>2. Useful but not necessary<br>3. not necessary |  |
| 3   | Is the acute asthmatic patient enrolled in CBHI membership?                                            | 1. Necessary<br>2. Useful but not necessary<br>3. not necessary |  |
| 4   | Residence                                                                                              | 1. Necessary<br>2. Useful but not necessary<br>3. not necessary |  |
| 5   | Season of index admission                                                                              | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |
| 6   | Duration of stay in a year after diagnosis                                                             | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |
| 7   | Does the asthma patient make scheduled visits? ((if yes go to next question; if no skip to Question 9) | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |
| 8   | Number of scheduled visits for asthma in the previous years                                            | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |

|    |                                                                                                                                           |                                                                 |  |
|----|-------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|--|
| 9  | Did the patient make ED visits the previous year?                                                                                         | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |
| 10 | History of previous year's hospitalizations due to acute asthmatic exacerbation (if yes, go to next question; if no, skip to Question 12) | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |
| 11 | If yes to question number 10, specify the number of admissions                                                                            | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |
| 12 | History of previous year ICU admission.                                                                                                   | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |
| 13 | History of chronic use of oral corticosteroids.                                                                                           | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |
| 14 | Date of index admission                                                                                                                   | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |
| 15 | ICD-11 Diagnosis of index admission and discharge                                                                                         | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |
| 16 | Eosinophil count                                                                                                                          | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |
| 17 | Pulse oximetry oxygen saturation measurement                                                                                              | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |
| 18 | Does the patient use supplemental oxygen on index admission? (If yes, go to the next question; if no, skip to Question 20)                | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |

|    |                                                                                                                                                             |                                                                 |  |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|--|
| 19 | If yes, question number 18, specifies the duration of use in hours                                                                                          | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |
| 20 | Was the patient diagnosed with an acute upper respiratory tract infection at index admission? (If yes, go to the next question; if no, skip to Question 22) | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |
| 21 | If yes, question number 20, specify the antibiotics used at index admission!                                                                                | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |
| 22 | Does the patient use a bronchodilator or SABA during index admission? (If yes, go to the next question; if no, skip to Question 24)                         | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |
| 23 | If yes, question number 22 specifies the drug used!                                                                                                         | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |
| 24 | Does the acute asthmatic patient receive systemic corticosteroid at index admission? (If yes, go to the next question; if no, skip to Question 26)          | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |
| 25 | If yes to question number 24, which corticosteroid drug is used?                                                                                            | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |
| 26 | Is the patient prescribed relief medication on hospital discharge?                                                                                          | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |
| 27 | Is any patient maintenance treatment medication (ICS) prescribed at hospital discharge? (If yes, go to the next question; if no, skip to Question 29)       | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |
| 28 | If yes to question number 27, specify the drug prescribed!                                                                                                  | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |

|    |                                                                                                                                                    |                                                                 |  |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|--|
| 29 | Does the acute asthmatic patient receive oral corticosteroids on hospital discharge? (If yes, go to the next question; if no, skip to Question 31) | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |
| 30 | If yes to question number 29, specify the drug prescribed.                                                                                         | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |
| 31 | Does the patient receive education on appropriate inhaler technique use on discharge?                                                              | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |
| 32 | Duration of stay in hospital during index admission specify                                                                                        | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |
| 33 | Does the patient stay in the ICU during the index admission?                                                                                       | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |
| 34 | Is there any appointment scheduled for a post-discharge visit? (If yes, go to the next question; if no, complete)                                  | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |
| 35 | If yes to question 34, specify the interval set for scheduled visits!                                                                              | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |
| 36 | Is an acute asthma patient readmitted within 90 days of the index admission and discharge?                                                         | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |
| 37 | If yes to question number 36, specify the date of readmission (MM/DD/YY)                                                                           | 1. Necessary<br>2. Useful but not necessary<br>3. Not necessary |  |

| S.N | Variables                                                     | Expert 1 | Expert 2 | Expert 3 | Expert 4 | Expert 5 | Expert 6 | Expert 7 | Content<br>Validity Ratio |
|-----|---------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|---------------------------|
| 1   | Age                                                           | 1        | 1        | 1        | 1        | 1        | 1        | 1        | 1                         |
| 2   | Gender                                                        | 1        | 1        | 1        | 1        | 1        | 1        | 1        | 1                         |
| 3   | Is the acute asthmatic patient enrolled in CBHI membership?   | 1        | 1        | 1        | 1        | 1        | 1        | 1        | 1                         |
| 4   | Residence                                                     | 1        | 1        | 1        | 1        | 1        | 1        | 2        | 0.714                     |
| 5   | Season of index admission                                     | 1        | 1        | 1        | 1        |          | 1        | 1        | 0.714                     |
| 6   | Duration of stay in a year after diagnosis                    | 1        | 1        | 1        | 2        | 1        | 1        | 1        | 0.714                     |
| 7   | Does the asthma patient make scheduled visits? ((if yes go to | 1        | 1        | 1        | 1        | 1        | 1        | 1        | 1                         |

|    |                                                                                                                                           |   |   |   |   |   |   |   |       |
|----|-------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|---|---|---|-------|
|    | next question; if no skip to Question 9)                                                                                                  |   |   |   |   |   |   |   |       |
| 8  | Number of scheduled visits for asthma in the previous years                                                                               | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 0.714 |
| 9  | Did the patient make ED visits the previous year?                                                                                         | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 0.714 |
| 10 | History of previous year's hospitalizations due to acute asthmatic exacerbation (if yes, go to next question; if no, skip to Question 12) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1     |
| 11 | If yes to question number 10, specify the number of admissions                                                                            | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 0.714 |

|    |                                                                                         |   |   |   |   |   |   |   |       |
|----|-----------------------------------------------------------------------------------------|---|---|---|---|---|---|---|-------|
| 12 | History of previous year ICU admission.                                                 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 0.714 |
| 13 | History of chronic use of oral corticosteroids.                                         | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1     |
| 14 | Date of index admission                                                                 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1     |
| 15 | ICD-11 Diagnosis of index admission and discharge                                       | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1     |
| 16 | Eosinophil count                                                                        | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 0.714 |
| 17 | Pulse oximetry oxygen saturation measurement                                            | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 0.714 |
| 18 | Does the patient use supplemental oxygen on index admission?<br>(If yes, go to the next | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 0.714 |

|    |                                                                                                                                                             |   |   |   |   |   |   |   |       |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|---|---|---|-------|
|    | question; if no, skip to Question 20)                                                                                                                       |   |   |   |   |   |   |   |       |
| 19 | If yes, question number 18 specifies the duration of use in hours                                                                                           | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1     |
| 20 | Was the patient diagnosed with an acute upper respiratory tract infection at index admission? (If yes, go to the next question; if no, skip to Question 22) | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 0.714 |
| 21 | If yes, question number 20, specify the antibiotics used at index admission!                                                                                | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 0.714 |

|    |                                                                                                                                                    |   |   |   |   |   |   |   |   |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|---|---|---|---|
| 22 | Does the patient use a bronchodilator or SABA during index admission? (If yes, go to the next question; if no, skip to Question 24)                | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 23 | If yes, question number 22 specifies the drug used!                                                                                                | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 24 | Does the acute asthmatic patient receive systemic corticosteroid at index admission? (If yes, go to the next question; if no, skip to Question 26) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 25 | If yes to question number 24, which                                                                                                                | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

|    |                                                                                                                                                       |   |   |   |   |   |   |   |       |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|---|---|---|-------|
|    | corticosteroid drug is used?                                                                                                                          |   |   |   |   |   |   |   |       |
| 26 | Is the patient prescribed relief medication on hospital discharge?                                                                                    | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1     |
| 27 | Is any patient maintenance treatment medication (ICS) prescribed at hospital discharge? (If yes, go to the next question; if no, skip to Question 29) | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 0.714 |
| 28 | If yes to question number 27, specify the drug prescribed!                                                                                            | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1     |
| 29 | Does the acute asthmatic patient receive oral medication                                                                                              | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1     |

|    |                                                                                         |   |   |   |   |   |   |   |       |
|----|-----------------------------------------------------------------------------------------|---|---|---|---|---|---|---|-------|
|    | on hospital discharge?<br>(If yes, go to the next question; if no, skip to Question 31) |   |   |   |   |   |   |   |       |
| 30 | If yes to question number 29, specify the drug prescribed.                              | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 0.714 |
| 31 | Does the patient receive education on appropriate inhaler technique use on discharge?   | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1     |
| 32 | Duration of stay in hospital during index admission specify                             | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 0.714 |

|    |                                                                                                                   |   |   |   |   |   |   |   |       |
|----|-------------------------------------------------------------------------------------------------------------------|---|---|---|---|---|---|---|-------|
| 33 | Does the patient stay in the ICU during the index admission?                                                      | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 0.714 |
| 34 | Is there any appointment scheduled for a post-discharge visit? (If yes, go to the next question; if no, complete) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1     |
| 35 | If yes to question 34, specify the interval set for scheduled visits!                                             | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1     |
| 36 | Is an acute asthma patient readmitted within 90 days of the index admission and discharge?                        | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1     |

|  |                                                                          |   |   |   |   |   |   |   |       |
|--|--------------------------------------------------------------------------|---|---|---|---|---|---|---|-------|
|  | If yes to question number 36, specify the date of readmission (MM/DD/YY) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1     |
|  | Content Validity Index                                                   |   |   |   |   |   |   |   | 0.853 |