Original Research

Prevalence of being 'high-risk' of hospitalization due to exacerbation among asthma patients aged ≥20 years in a district of Sri Lanka

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DOI: https://doi.org/10.4038/jccpsl.v30i2.8670

Received on 23 Nov 2023
Accepted on 14 May 2024

Abstract

Introduction: Hospitalizations due to exacerbated asthma remains high in Sri Lanka leaving a huge burden on the healthcare system. Identification of the burden of 'high risk asthma patients' for hospitalization due to exacerbation is a cost-effective strategy for prioritizing management options.

Objectives: To estimate the prevalence of 'high-risk asthma patients' and selected risk predictors for hospitalization due to exacerbation among asthma patients aged ≥20 years in the district of Gampaha, Sri Lanka

Methods: A community-based descriptive cross-sectional study was conducted among 1200 asthma patients aged ≥20 years, selected using a multistage sampling technique. The risk for hospitalization was assessed using a newly developed and validated risk prediction model. High-risk asthma patients were defined according to the cut-off value of the summary risk score of the model.

Results: The prevalence of 'high-risk asthma patients' for hospitalization due to exacerbation was 16.4% (95% CI: 14.2, 18.6). The prevalence of selected risk predictors: age ≥60 years 24.2% (95% CI: 21.9, 26.7), poor educational attainment 67.3% (95% CI: 64.5, 70.0), having diabetes mellitus 18.8% (95% CI: 16.5, 21.0), family history of asthma 41.3% (95% CI: 38.5, 44.2), ever smoked 12.2% (95% CI: 10.2, 14.1), ever intubated or given intensive care 2.8% (95% CI: 1.8, 3.7), previous hospitalizations due to exacerbations 6.6% (95% CI: 5.1, 8.0), having uncontrolled asthma 63.6% (95% CI: 60.8, 66.7), having symptomatic GORD 18% (95% CI: 15.7, 20.2) and having body mass index (BMI) ≥25 kg/m^2 36.3% (95% CI: 33.5, 39.0).

Conclusions & Recommendations: A significant proportion of asthma patients being at risk of hospitalization indicates the need to adopt cost-effective asthma management strategies to achieve better control of the disease. Prompt primary healthcare interventions are required to address modifiable risk predictors among asthma patients.

Keywords: *asthma, hospitalization, high risk patients, risk predictors, prevalence*

Introduction

Asthma is a chronic respiratory condition affecting people in both affluent and developing countries (1). Asthma related hospitalizations remain substantially high across the world despite the therapeutic advancements in asthma care (2). The prevalence of asthma among Sri Lankan adults is found to be much higher compared to the other South Asian countries (3). It has been one of the leading causes for hospitalizations in government hospitals in Sri Lanka over the past two decades. According to the Annual Health Bulletin 2019, diseases of the respiratory system including asthma had been the third leading cause of admissions to government hospitals in Sri Lanka for the past ten years. Hospitalization rates due to asthma had been persistently high from 2008 to 2015 (4). In 2015, asthma claimed the highest hospitalization rate among the main diseases selected for the analysis including ischemic heart diseases, hypertensive diseases and diabetes (5).

It is estimated that a large proportion of asthma care expenses is due to the high cost of asthma related hospitalizations (6). Rising hospitalization rate due to asthma results in high economic burden to the country's health service and national budget in general. Therefore, reducing hospitalizations due to asthma has been identified as the key to reducing the overall cost of asthma care. Various interventions have been shown to reduce hospital admissions of asthmatics, including specialist care (7) and personalized education programmes (8). However, these interventions would be best aimed at patients who are at higher risk of adverse outcomes. Thus, risk stratification and identification of high-risk patients is essential in adopting these interventions (9). Further, the large number of asthma patients in the country highlights the need of efficient resource management in asthma care (10). To achieve this goal, decision makers need information on high-risk patients who will need specialized treatment. Predictive modelling has been widely applied to obtain this information, and to enhance decision making process in many developed countries (11-12).

According to studies done in developed countries, various factors have been identified as risk predictors for hospitalizations due to exacerbated asthma. A number of studies have developed risk stratification schemes for asthma patients based on risk predictors, utilizing computerized administrative databases (9, 12-13). However, results of these studies have frequently been too complicated to apply in local settings. Therefore, identification of risk predictors and their burden in Sri Lanka is important in managing asthma patients.

Adaptation of practical and realistic management strategies in terms of different health care systems is one of the main approaches recommended by Global Initiative for Asthma in providing asthma care (14). Prevalence data on 'high risk patients' and 'risk predictors' for asthma related hospitalizations would provide strong evidence to health care providers for advocacy, resource allocation and planning cost-effective control strategies.

Methods

A community-based descriptive cross-sectional study was carried out in the District of Gampaha in the Western Province, Sri Lanka. Data collection was carried out from October 2019 to January 2020. Asthma patients aged 20 years and above, who were residing in the District of Gampaha for at least 6 months prior to the date of survey were taken as the study population. Inclusion criteria for 'asthma patient' were a person who has been diagnosed with asthma, confirmed by medical records or diagnosis card, or who has sought medical care (inpatient or outpatient) for asthma during the past 12 months, confirmed by medical records or was on medication for asthma (including inhalers, aerosols, or tablets) during the past 12 months, confirmed by possession of the medication, prescriptions, or medical records. Those who had chronic lung diseases other than asthma, confirmed by medical records, those with

severe mental disability and those living in institutions were excluded.

Sample size was determined based on the minimum sample required to detect the expected prevalence of 'high risk for hospitalization' among adult asthma patients, with a pre-determined level of precision of 3% and 95% confidence interval (CI). The expected prevalence of 'high risk for hospitalization' was taken as 21% (15). Since cluster sampling method was adopted in selecting study units, the effect of clustering was overcome by making a correction for design effect (1.48). The calculated minimum sample size was 1048 and an additional 14% was added to account for non-response among participants. Hence the total sample size was decided as 1200.

A multi-staged sampling technique was used to select the total study sample. The total sample of 1200 was obtained from 48 clusters with 25 study units in each cluster. A cluster was defined as a group of asthmatics aged 20 years and above in a Grama Niladhari (GN) division.

Gampaha District comprises of 13 divisional secretariat (DS) areas and study units were selected from five randomly selected DS areas. The 48 GNDs (clusters) to be included in the study was determined by probability-proportionate-to-size (PPS) sampling technique. As the next stage of sampling, 25 eligible study subjects were selected from the households of each of these selected GNDs. Identification of the index house in the respective GND was done by selecting a house randomly from the list of households in each GND. The immediate adjacent house to the right of the front door of the index house was considered as the second house, when visiting the households. In the event of not finding any of the eligible study subjects from a household, the search continued in consecutive households. Only one eligible asthma patient was selected from each selected household using simple random sampling. This procedure was carried out until 25 eligible participants were selected from each GND.

A country specific risk prediction model was developed and validated by authors, based on risk factors for hospitalization due to exacerbated asthma, identified from a hospital-based case control study conducted in Gampaha District (16). The 'high risk for hospitalization' among participants was assessed by applying this model. An interviewer-administered questionnaire was used to obtain information on risk predictors.

Table 1 shows the newly developed and validated risk prediction model containing ten risk predictors with an individual risk score assigned to each predictor. The summary risk score of the model ranged from 1 to 11. The interviewer administered questionnaire had a provision to indicate the score assigned to each predictor and thereby the summary risk score for each study subject. When assigning the scores, the reference level was assigned a score of zero and each predictor was assigned the agreed upon score.

Asthma patients 'high risk for hospitalization' were defined based on their summary risk score in the risk prediction model. Patients who scored more than the cut-off value of 4.5 were considered 'high risk for hospitalization'. This optimal cutoff value to categorize each patient to high risk or low risk was determined by Receiver Operating Characteristic (ROC) curve analysis. At the 4.5 cut-off level, the model gave a sensitivity of 69.0% (95% CI: 61.7%, 76.2%), a specificity of 86.1% (95% CI: 79.4%, 92.8%) and area under curve of 0.83 (95% CI: 0.78, 0.88).

Two pre-intern medical officers and two student nursing officers were recruited and trained as research assistants (RAs) to assist the principal investigator (PI) in the data collection. Informed written consent was obtained from each participant before administering the questionnaire. The participants were inquired on sociodemographic characteristics and risk predictors for hospitalizations: having uncontrolled asthma, family

history of asthma, diabetes mellitus, symptomatic gastroesophageal reflux disease (GORD), ever smoked, ever intubated/given ICU care, previous hospitalizations due to exacerbations and generalized obesity. Questions on risk predictors in the questionnaire were based on accepted definitions that have been operationalized to local context. The opinions of a panel of experts were taken to refine the questions. The level of asthma symptom control was inquired using four questions to identify different levels of asthma control based on the 2018 GINA guidelines on Management of Asthma (14). The generalized obesity (BMI ≥25 kg/m^2) was defined based on the proposed classification of BMI for adult Asians by the WHO (17).

Table 1: Predictor variables in the final risk prediction model

Predictor variable	Categories	Assigned score
Age of the asthma patient	≥ 60 years	1
	< 60 years	0
Level of education	≤ GCE Ordinary Level[1]	1
	> GCE Ordinary Level	0
Having diabetes mellitus	Yes	1
	No	0
Family history of asthma	Yes	1
	No	0
Ever smoked	Yes	1
	No	0
Ever intubated/ given intensive care unit care	Yes	1
	No	0
Previous hospitalizations due to exacerbations	Yes	2
	No	0
Uncontrolled asthma	Yes	1
	No	0
Having symptomatic GORD[2]	Yes	1
	No	0
Body mass index	≥25 kg/m^2	1
	<25 kg/m^2	0
Total score		**11**

[1]General Certificate of Education; [2]Gastroesophageal reflux disease

Data analysis

Data analysis was done using Statistical Package for the Social Sciences Software (Version 20). The socio-demographic characteristics of the participants were described by frequency distribution. The prevalence of 'high-risk asthma patients' and selected risk predictors for hospitalization due to exacerbation were estimated with 95% CI.

Results

Out of the selected 1200 eligible asthma, 75 could not be interviewed, of whom 42 refused to participate and 33 were not available at home despite three home visits by the field investigators. Hence, the response rate was 93.8% (1125). There was no significant difference between basic demographic characteristics of the respondents and non-respondents.

Socio-demographic characteristics of the participants are given in Table 2. The age ranged from 20-86 in completed years. Median age was 61 years (IQR 12). Majority were Sinhalese (90.6%)

and 64% were Buddhist. The level of education of 59.9% of the participants was between grade 1 to 10. Majority were currently unemployed (58.5%) and 35.9% had a monthly household income of Rs. 20 001-40 000.

Table 2: Socio-demographic characteristics of the participants (N=1125)

Characteristic	No.	%
Sex		
Male	494	43.9
Female	631	56.1
Age categories (years)		
20-39	466	41.4
40-59	387	34.4
60-79	246	21.9
80 and above	26	2.3
Ethnicity		
Sinhala	1019	90.6
Tamil	54	4.8
Muslim	51	4.5
Burgher	1	0.1
Religion		
Buddhist	720	64.0
Hindu	28	2.5
Islam	52	4.6
Catholic/Christian	325	28.9
Highest level of education		
No schooling	83	7.4
Grade 1-10	647	59.9
GCE (Ordinary Level) completed	170	15.5
Grade 11-12	71	6.3
GCE (Advanced Level) completed	107	9.5
University/ Higher education	20	1.8
Employment status		
Currently unemployed	658	58.5
Currently employed	467	41.5
Household income (Rupees)		
≤5000	47	4.2
5001 - 10 000	208	18.5
10 001 - 20 000	323	28.7
20 001 - 40 000	404	35.9
≥40 001	143	12.7

Table 3 shows the prevalence of independent risk predictors for hospitalization' among participants. Only 24.2% of them were in the age group of 60 years and above, while 41.3% had a family history of asthma; 18.8% had diabetes while 18% had symptomatic GORD; 67.6% had uncontrolled asthma; 12.2% (n=137) of patients gave a history of ever smoking; and 6.6% (n=74) reported to have previous hospitalization due to exacerbated asthma. Only 2.8% gave a history of ever being intubated or

given ICU care and 36.3% being obese with BMI ≥25 kg/m^2.

The summary risk score for hospitalization of the participants was positively skewed (standardized skewness of 7.26). The summary risk score ranged from zero to 9 with median summary risk score of 3 (IQR=2 to 4).

Table 3: Prevalence of selected risk predictors for hospitalizations due to exacerbated asthma

Risk predictor	Prevalence %	95% CI
Age ≥ 60 years	24.2	21.7, 26.7
Educated ≤ G.C.E. O/Level	67.3	64.5, 70.0
Having diabetes mellitus	18.8	16.5, 21.0
Family history of asthma	41.3	38.5, 44.2
Ever smoked	12.2	10.2, 14.1
Ever intubated/ given ICU care	2.8	1.8, 3.7
Previous hospitalizations due to exacerbations	6.6	5.1, 8.0
Having uncontrolled asthma	63.6	60.8, 66.7
Having symptomatic GORD	18.0	15.7, 20.2
Body mass index ≥25 kg/m^2	36.3	33.5, 39.0

ICU- Intensive care unit; GORD- Gastroesophageal reflux disease

Asthma patients who obtained a summary risk score of 4.5 or more were categorized as 'high risk for hospitalization'. Out of 1125 asthma patients, 185 had a risk score of 4.5 or more. Hence, the prevalence of 'high risk for hospitalization' due to exacerbations was 16.4 per 100 asthma patients (95% CI: 14.2, 18.6).

Discussion

A community-based cross-sectional study design was selected to estimate the prevalence of high-risk asthma patients for hospitalization due to exacerbation, as it gives a representative picture of the burden at a given point of time (18). The district of Gampaha was selected as newly developed risk prediction model which is applied to select high-risk asthma patients was proven valid for Gampaha District (16). Multi-stage sampling method used in this study, permitted the intended sample to be as representative as possible (19). The cluster effect was lessened by selecting only one individual from each household.

Selection of most practical and reliable criteria in defining 'asthma patients' for this population survey had been challenging, as there is no single investigation or pathognomonic feature to detect asthma. It had been emphasized that a single definition of asthma would not be applicable to every situation, and the selection of the definition should primarily be based on the aim of the research (20). The aim of the present study was not to estimate the asthma prevalence in the population, but to identify 'high risk' asthma patients for hospitalization. Therefore, more specific criteria were used in recruiting asthma patients, such as physician diagnosis, prescription, and use of medication for asthma.

The risk of hospitalization among asthma patients was assessed by applying a locally developed and validated risk prediction model. Since we used a validated risk prediction model and assessed the prevalence according to the validated cut off points; this prevalence value could be considered as the true prevalence of 'high risk for hospitalization' in the study population. However, these prevalence estimates possibly will not be generalized to the entire population of Sri Lanka as this study was carried out in five DS areas in the district of Gampaha.

The prevalence of 'high risk for hospitalization' due to exacerbation among asthma patients aged 20 years

and above in the present study was 16.4%. A similar study conducted in Southern California reported 11% 'at risk' prevalence for hospitalization due to exacerbations among adult asthma patients (9). This prevalence estimate was derived from a risk prediction model developed for adults based on a computer-based hospital database. Risk predictors identified for hospitalization due to exacerbated asthma were previous year hospitalizations, beta-agonist dispensing, oral steroid dispensing, and level of income. Since the above model was developed based on a hospital database, its risk predictors had been limited to the variables that can be obtained from the database.

In the absence of a published local study that had evaluated the above prevalence, it was not possible to compare the prevalence of 'high risk for hospitalization' among asthma patients estimated by the present study. However, it is indicated that the present model was successful in identifying the high-risk adult asthma population for hospitalizations, as it contained most of the risk predictors which had proven to be clear predictors of future asthma hospitalization by previous studies (15, 21-22).

Estimated prevalence of modifiable risk predictors of this model would be useful in planning cost effective management strategies for asthma patients. Generalized obesity was found in 36.3% of asthma patients in the present study. Using the same Asian BMI cutoffs, a community-based cross- sectional study conducted among 463 adults in Colombo District reported 31.2% prevalence of obesity (23). We reported 12.2% prevalence of 'being ever smoked' among asthmatics, whereas in a community-based survey on asthma, 20.6% of self-reported asthmatics found themselves to be 'current smokers' (3). They have defined 'current smoking' based on a positive response to the question "Do you currently smoke any tobacco products such as cigarettes, cigars, or pipes?" and in our study 'being ever smoked' was defined based on having smoked at least 100 cigarettes, cigars or sticks of bidi in their lifetime.

We found 18.8% prevalence of previously diagnosed diabetes among adult asthma patients. This was high compared to the national prevalence of previously diagnosed diabetes among adults (14.3%) estimated from the Sri Lanka and Ageing Survey 2018/2019 (24). We reported an 18% prevalence of symptomatic GORD among asthma patients in the community, whereas a hospital based cross-sectional study conducted among patients attending asthma clinics reported 59.4% prevalence of GORD symptoms (25). However, their prevalence estimates were based on a symptom scale for GORD and our estimates were based on previously diagnosed symptomatic GORD. The present study also found a substantially higher proportion of uncontrolled asthma (63.6%) among asthma patients. Therefore, appropriate management of the disease together with comorbid conditions such as diabetes and symptomatic GORD is essential in minimizing future hospitalization risk of asthmatics.

Limitations

This cross-sectional study was carried out in five Divisional Secretariat areas in the district of Gampaha. Thus, the findings of this study may not be generalized to the whole country. For the sample size calculation, the expected prevalence of at-risk population was taken as 21% (15) as it was the only study which assessed the percentage of high-risk asthma patients using a similar approach to the current study even though their measurement tool was different from the current study.

Conclusions & Recommendations

The prevalence of 'high risk for hospitalization' among asthma patients due to exacerbations in the district of Gampaha was high at 16.4%. Furthermore, the prevalence of modifiable risk predictors such as generalized obesity and smoking was also high among asthma patients. We also reported a high prevalence of previously diagnosed diabetes and

symptomatic GORD among asthma patients.

The asthma patients at 'high risk for hospitalization' need access to specialized care to obtain better control of their diseases. A low-cost risk prediction model should be made available at primary care settings for early detection and referral of high-risk patients to specialized care. Promotion of healthy diet, physical activity and smoking cessation counselling services should be strengthened for asthma patients at primary health care level as a primary preventive measure. Comorbid conditions such as diabetes and symptomatic GORD should be managed appropriately in asthma patients, to minimize their risk of hospitalization due to exacerbations.

Public Health Implications

- The high prevalence of 'high risk for hospitalization' among asthma patients and selected risk predictors for hospitalization suggests major implications to the country's health care service and national budget in general.
- Considering the substantial proportion of asthma patients in the community being at risk of hospitalization due to exacerbations, introduction of newly developed risk prediction model as a low-cost tool into the existing primary healthcare system would enable early detection and referral for specialized care.
- Furthermore, addressing modifiable risk predictors through primary healthcare interventions is important to minimize their risk of hospitalizations.

Author Declarations

Competing interests: The authors declare that they have no competing interests.

Ethics approval and consent to participate: Ethics clearance was granted by the Ethics Review Committee of the Faculty of Medicine, University of Colombo, Sri Lanka. (Reference number:EC-17-148). Informed written consent was obtained from each participant prior to data collection.

Funding: Self-funded

Acknowledgements: We wish to thank the health administrators of the district, clinicians of the selected hospitals for the hospital-based case control study, participants of the panel of experts, and the study participants for their support, contribution, and participation.

Author contributions: DHP led the design of the study, conducted the study, analysed data and drafted the initial manuscript with expert inputs from VK and WS. All authors read and approved the final version of the manuscript.

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