

Original Article

Prevalence of Asthma among Adults in Northwestern Ethiopia: Implications for Health Planning and Management

Atalaye Nigussie¹, Belsti Atnkut¹, Gedif Mulat Alemayehu¹, Zelalem Meraf Woldie¹, Nigussie Adam Birhan¹, Destaw Mullualem¹, Tessema Astatkie*²

¹College of Natural and Computational Science, Injibara University, Injibara, Ethiopia

²Faculty of Agriculture, Dalhousie University, Truro, Nova Scotia, Canada

Corresponding authors*: astatkie@dal.ca

Abstract

Background: Bronchial asthma is a chronic inflammatory airway disease that substantially burdens individuals and healthcare systems. Regular investigation of its severity and identifying the factors that lead patients to seek medical care is crucial for effective health planning, management, and prevention to reduce healthcare costs and morbidity/mortality rates while fostering productive citizenship. The study aimed to assess the magnitude of asthma severity and associated factors that prompt adult patients to visit healthcare services in the Awi administrative zone of Northwestern Ethiopia.

Method: This study used a cross-sectional study design. Data from 662 asthma patients were collected using structured questionnaires and multistage sampling. The collected data were analyzed using the ordinal logistic regression model to determine how asthma status (the dependent variable) is affected by sociodemographic (independent) variables and the chi-square test of independence to determine the significance of the association between asthma status and the sociodemographic variables.

Results: Among the 662 asthma patients, the severity of 43.5%, 41.84%, and 14.65% of them was mild, moderate, and severe, respectively. The factors that affect the severity of asthma significantly are bad smells in the environment (AOR=0.02, $p<0.001$), marital status (AOR=0.003, $p<0.001$), educational level, physical exercise (AOR=5127.7, $p<0.001$), family history of asthma (AOR=90.05, $p<0.001$), presence of animals at home (AOR=0.0002, $p<0.001$), high asthma distribution season, limited daily activity (AOR=0.479, $p=0.027$), and energy source for cooking (AOR=4.63x10⁻⁶, $p<0.001$).

Conclusion: The findings highlight the need for tailored interventions to promote asthma disease prevention strategies and the need to implement several interventions by the Awi Zone health office and non-governmental organizations to reduce asthma disease severity.

Keywords: Northwest Ethiopia, logistic regression model, bad smell, Bronchial asthma, Healthcare systems

Citation : Nigussie A, Atnkut B, Alemayehu GA et al. Prevalence of Asthma among Adults in Northwestern Ethiopia: Implications for Health Planning and Management. *Ethiop Med J* 62 (4) 253-260

Submission date : 29 July 2024 **Accepted:** 18 September 2024 **Published:** 01 October 2024

Introduction

Asthma is a chronic inflammatory disease of the airways that can cause shortness of breath, tightness in the chest, coughing, and wheezing symptoms (1). Asthma is one of the most prevalent chronic inflammatory illnesses of the airway, resulting in increased contractibility of the surrounding smooth muscles and worsened pulmonary function (2). If this inflammation is not treated, it will lead to an asthma attack and tightens the muscles around the bronchial tubes causing the airways to narrow. Mucus is produced within the bronchial tubes, further restricting airflow (3).

Asthma is considered a public health problem world-

wide (4), negatively affecting patients, their families, and the community. It also creates a major economic and social burden (5). Asthma is documented as a common chronic disease that affected 5–10% of the population during the past 20 years (6).

The prevalence of asthma in Africa is estimated to be around 74 million people (11.7%) in 1990 and 120 million people (12.8%) in 2010 (4). During these years, the cumulative prevalence of asthma was the highest in South Africa (53%, 5-12 years) in 1997, followed by Egypt (26.5%, 11-15 years) in 2005, Nigeria (18.4%, 15-35 years) in 1995, and Ethiopia (16.3%, >20 years) in 1997 (4).

Bronchial asthma is one of the public health problems in Ethiopia. The prevalence of bronchial asthma has increased recently with different contributing factors such as cigarette smoking (7), household economic status (8), occupational condition (9), type of residence (10), and a family history of asthma (11). Bronchial asthma is one of the diseases that cause chronic morbidity and mortality worldwide (12, 13). One of the significant causes of bronchial asthma-related morbidity is poor adherence to drug treatment (14).

Worldwide, the economic costs associated with asthma are estimated to exceed those of TB and HIV/AIDS combined (15). A study from Portugal showed that the use of tobacco, kerosene, paracetamol, and allergen skin sensitization to house dust mites was associated with an increased risk of wheezing (16).

Although asthma is a common problem in Ethiopia, it is not receiving the attention it deserves for proper management (17). Therefore, this study aimed to provide evidence-based information about the severity pattern of bronchial asthma and the associated risk factors in adult patients in the Awi administrative zone.

Materials and Methods

Study area

The study was conducted in the Awi administrative zone, Amhara Regional State of Ethiopia. This zone is 447 km from Addis Ababa and 118 km from Bahir Dar (18). It is situated in the northwestern part of the country, at an elevation of 700 to 2920 meters above sea level. The 2018 population of the zone was estimated to be 1,264,203 (1,057,604 rural, 206,599 urban residents), with 50.1% male and 49.9% female residents (19).

Variables of the study

The independent variables are sociodemographic characteristics: age, gender, educational status, income level, residence, occupation, type of fuel used for cooking, unpleasant odors, smoking cigarettes, family history of asthma, placement of the kitchen in the house, limitations on daily activities, season, presence of animals at home, exercise habits, experiencing drug discontinuation, house ownership, and marital status. The dependent variable is bronchial asthma level of severity, categorized as mild, moderate, and severe.

Study design and study period

A cross-sectional study was conducted from December 2022 to November 2023 to determine the factors associated with bronchial asthma among adult patients in Awi administrative Zone.

Sample size determination

The sample size (n) was determined using the formula described in (20).

$$n = \frac{Z^2 p(1-p)}{d^2}$$

The formula is $n = \frac{Z^2 p(1-p)}{d^2}$, where Z is the standard normal distribution value for a 95% confidence level

(1.96), p is the expected severity (0.5), and d is the margin of error (0.04). Using these values in the formula and adding 10% for potential non-response, a final sample size of n=662 was calculated.

Sampling method

A two-stage sampling procedure was used. In the first stage, two strata of health services (5 hospitals, and 49 healthcare centers) were created based on the type of service they provide. Then 3 hospitals (Injibara General Hospital, Chagni Hospital, and Dangila Hospital) and 5 healthcare centers (Ayehu, Adiskedam, Kessa, Tilili, and Gemeja Bet) were randomly selected. In the second stage, n=662 was partitioned to the 8 hospitals and healthcare centers proportionally according to the number of adult bronchial asthma patients admitted, and the participants were randomly selected.

Data collection

This study utilized close-ended questionnaires, and the data were collected through face-to-face interviews. All participants of the survey provided informed consent.

Operational definition

Mild severity is defined as the subject not using accessory muscles, the subject's respiratory rate being between 12 and 20, the heart rate being between 60 and 100, and oxygen saturation being $\geq 95\%$.

Moderate severity is defined as the subject using accessory muscles, speaking in phrases, having an agitated mental status, having a respiratory rate between 20 and 30, a heart rate between 100 and 120, and oxygen saturation between 90% and 95%.

Severe severity is defined as the subject using accessory muscles, the subject's speech being in words, the mental status being distressed, the respiratory rate being >30 , the heart rate being >120 , and oxygen saturation being $<90\%$. These categories are based on GINA-pocket-2015 clinical methods.

Data analysis and process

Descriptive statistics were used to describe the socio-demographic characteristics. Ordinal logistic regression analysis with the Odds ratio model was utilized to determine the influence of the independent variables on the dependent variable.

Ethical considerations

Ethical approval was obtained from Injibara University's Institutional Research Ethics Review Committee (Ref. No. IU/IRERC/03/24). The participants were informed about the study's goals, and their verbal consent was obtained. Their right to refuse or to withdraw from participation was honored, and the confidentiality of the information provided by each participant was strictly maintained. The study did not involve using individual participants' names, images, or videos.

Results

Descriptive statistics

The severity of asthma in the different categories of socio-demographic and clinical characters is shown in Table 1.

Table 1: Severity of asthma in the different categories of socio-demographic characters.

Variable	Category	Status of bronchial asthma among adult patients n (% of severity within each category)			
		Mild	Moderate	Severe	Total n (%)
Gender	Female	121 (33.4)	234 (64.6)	7 (1.93)	362 (54.7)
	Male	156 (52.0)	54 (18.0)	90 (30.0)	300 (45.3)
Monthly income	<6000	120 (42.9)	127 (45.4)	33 (11.8)	280 (42.3)
	6000-10000	132 (45.2)	113 (36.7)	47 (16.1)	292 (44.2)
	>10000	36 (40.0)	37 (41.1)	17 (18.9)	90 (13.6)
Drug discontinuation	Yes	188 (47.5)	118 (29.8)	90 (22.7)	396 (59.8)
	No	100 (37.6)	159 (59.8)	7 (2.6)	266 (40.2)
Smoking cigarette	Yes	69 (41.6)	77 (46.4)	20 (12.1)	166 (25.1)
	No	219 (44.2)	200 (40.3)	77 (15.5)	496 (74.9)
Exercise habit	Yes	201 (57.1)	75 (21.3)	78 (22.2)	352 (53.2)
	No	87 (28.1)	202 (65.2)	21 (6.8)	310 (46.8)
Bad smell	Yes	165 (39.8)	157 (37.5)	97 (23.2)	419 (63.3)
	No	123 (50.6)	120 (49.4)	0 (0.0)	243 (36.7)
Residence	Rural	93 (30.2)	196 (63.6)	19 (6.2)	308 (46.5)
	Urban	195 (55.1)	81 (22.9)	78 (22.0)	354 (53.5)
Fuel for cooking	Electric	25 (35.7)	12 (17.1)	33 (47.1)	70 (10.6)
	Charcoal/wood	263 (44.4)	265 (44.8)	64 (10.8)	592 (89.4)
Marital status	Married	256 (57.3)	121 (27.1)	70 (15.7)	447 (67.5)
	Others	32 (14.9)	156 (72.6)	27 (12.6)	215 (32.5)
Age	<28	31 (42.5)	25 (34.3)	17 (23.3)	73 (11.0)
	28-38	173 (52.4)	114 (34.6)	43 (13.0)	330 (49.9)
	38-48	72 (34.0)	114 (53.8)	26 (12.3)	212 (32.0)
	>48	12 (25.5)	24 (51.1)	11 (23.4)	47 (7.1)
Layout of the kitchen	Inside	88 (43.8)	94 (6.8)	19 (9.5)	201 (30.4)
	Outside	200 (43.4)	183 (39.7)	78 (16.9)	461 (69.6)
Limited daily activities	Yes	165 (38.4)	181 (42.1)	84 (19.5)	430 (65.0)
	No	123 (53.0)	96 (41.4)	13 (5.6)	232 (35.0)
Presence of animals	Yes	221 (43.6)	252 (49.7)	34 (6.7)	507 (75.7)
	No	67 (43.2)	25 (16.1)	63 (40.7)	155 (23.4)
House ownership	Owned	168 (50.6)	136 (41.0)	28(8.43)	332 (50.2)
	Rented-Gov	4 (33.3)	6 (50.0)	2 (16.7)	12 (1.8)
	Rented-Private	120 (37.7)	129 (40.3)	97 (30.5)	318 (48.0)
Family history of asthma	Yes	85 (26.2)	150 (46.2)	90 (27.7)	325 (49.1)
	No	203 (60.2)	127 (37.7)	7 (2.1)	337 (50.9)
Season	Winter	1 (33.3)	0 (0.0)	2 (66.7)	3 (0.4)
	Summer	136 (39.4)	209 (60.6)	0 (0.0)	345 (52.1)
	Spring	0 (0.0)	43 (1.0)	0 (0.0)	43 (6.5)
	Autumn	151 (55.7)	25 (9.2)	95 (35.1)	271 (40.9)
Occupation	Farmer	74 (28.5)	162 (62.3)	21 (8.1)	260 (39.3)
	Trader	40 (75.5)	13 (24.5)	0 (0.0)	53 (8.0)
	G. employee	121 (68.8)	55 (31.3)	0 (0.0)	176 (26.6)
	Self-employee	53 (30.6)	44 (25.4)	76 (43.9)	173 (26.1)
Education level	Illiterate	74 (30.8)	145 (60.4)	21 (8.8)	240 (36.3)
	Reading/writing	175 (52.7)	81 (24.4)	76 (22.9)	332 (50.2)
	Others	39 (43.3)	51 (56.7)	0 (0.0)	90 (13.6)

Accordingly, 54.7% of the respondents were female and 45.3% male. However, there is a glaring difference between the severity level of males and females, where a higher percentage of females have moderate severity (64.6%). In comparison, only 18.0% of the males have moderate severity, and a higher proportion of the males (30.0%) have severe asthma compared to their female (1.9%) counterparts (**Figure 1**).

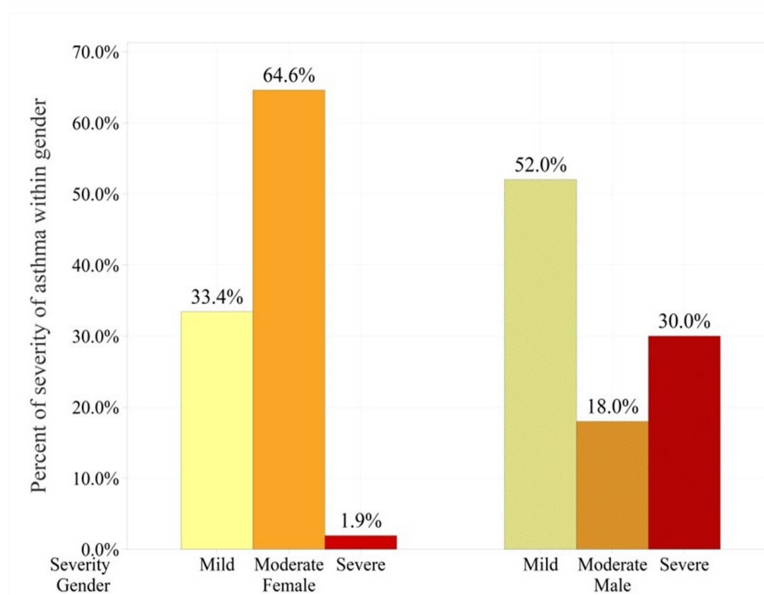


Figure 1: Status of bronchial asthma among adult male and female participants.

Regarding monthly income, 42.3%, 44.2%, and 13.6% of the respondents have income <60000, 6000 – 10000, and >10000, respectively, and respondents with >10000 income have more severe asthma. 59.8% of the respondents did not finish their drug, and 22.7% of those had severe asthma. Among all respondents, 25.1% smoked cigarettes, and 74.9% did not.

Among all asthma patients, 50.2% owned their house, and 48.0% rented from a private owner. Still, the severity level varied substantially, where 50.6% vs. 8.43% and 37.7% vs. 30.5% of the participants who lived in their own house and rented units have mild vs. severe severity, respectively. Regarding fuel for cooking, 10.6% and 89.4% of the respondents used electric and charcoal, respectively. There is no significant difference between the respondents with a family history of asthma (49.1%) and those without (50.9%).

Factors associated with the severity of asthma

The significance of the impact of the studied factors on the prevalence of asthma is shown in Table 2. Accordingly, smoking cigarettes, drug discontinuation, layout of the kitchen, and monthly income have no significant effect on the severity of asthma. However, exercise habits, family history of asthma, occupation, bad smell in the environment, education level, fuel used for cooking, seasons, limited daily activity, and marital status have a significant effect on the severity of asthma, and

these factors are included in the multivariable ordinal logistic regression analysis.

The results showed that exercise habits, family history of asthma, occupation, bad smell in the environment, education level, fuel used for cooking, seasons, limited daily activity, and marital status significantly affect the severity of asthma. Asthma patients who do not smoke cigarettes were 0.00000175 times (AOR=0.00000175, very close to zero) more likely to have severe asthma than those who smoke cigarettes. Asthma patients who use electricity for cooking were 4.63×10^{-6} times (AOR= 4.63×10^{-6} , 95%CI: 7.35×10^{-7} , 2.9×10^{-5}) less likely to have severe asthma than those using charcoal and wood.

The odds of having severe asthma if a patient is not exposed to bad smells is < 45% less likely to have severe asthma. The odds of severe asthma level for patients not doing physical exercise is 5127.7 times (AOR: 5127.7, 95% CI: 188.2, 139728.1) more likely than their counterparts. The odds of having severe asthma for patients who have a family history of asthma is 90.05 times (AOR=90.05, 95% CI: 17.16, 472.48) more likely than that of those with a family history of asthma. Patients whose education level is at illiteracy and reading/writing levels have 0.001 (AOR=0.001, 95% CI: 0.00006, 0.315) and 0.016 (AOR=0.016, 95% CI: 0.001, 0.188) times higher odds of having severe asthma than patients whose education level is in the others category.

Table 2: Variables associated with the severity level of asthma, Crude Odds Ratio (COR), Adjusted Odds Ratio (AOR), and P-value of the ordinal logistic regression model.

Variable	COR (95% CI)	AOR (95% CI)	P-value
Severity level			
Mild		0.016 (1.6x10 ⁻⁵ , 1.433)	0.071
Moderate		58.616 (0.607, 5.7x10 ⁴)	0.081
Sever		1.00	
House ownership			
Private	0.510 (0.379, 0.686)	0.205 (0.100, 0.423)	<0.001
Rented from government	1.543 (0.606, 3.929)	1367.8 (33.5, 55825.0)	<0.001
Rented from a private owner	1.00	1.00	
Residence			
Urban	0.644 (0.482, 0.861)	7.254 (1.67, 31.55)	0.008
Rural	1.00	1.00	
Exercise habit			
No	1.808 (1.35, 2.42)	5127.7 (188.2, 139728.1)	<0.001
Yes	1.00	1.00	
Drug discontinuation			
No	0.904 (0.677, 1.207) ^a		
Yes	1.00		
Family history of asthma			
Yes	5.381 (3.91, 7.40)	90.05 (17.16, 472.48)	<0.001
No	1.00	1.00	
Gender			
Male	9.893 (6.98, 14.03)	15.876 (6.29,40.09)	<0.001
Female	1.00	1.00	
Occupation			
Farmer	0.374 (0.252, 0.556)	0.248 (0.015, 3.999)	0.326
Trader	0.060 (0.029, 0.123)	0.052 (0.007, 0.402)	0.005
Government employee	0.083 (0.052, 0.132)	0.005 (0.010, 0.031)	0.001
Self-employee	1.00	1.00	
Education level			
Illiterate	0.877 (0.570, 1.350)	0.001 (0.00006, 0.315)	0.001
Reading/writing	1.447 (1.057, 1.981)	0.016 (0.001, 0.188)	<0.001
Others	1.00	1.00	
Smoking cigarette			
No	0.992 (0.714, 1.377)		
Yes	1.00		
Presence of animals			
No	2.300 (1.583, 3.341)	0.0002 (0.00001, 0.002)	<0.001
Yes	1.00	1.00	
Bad smell			
No	0.450 (0.332, 0.608)	0.020 (0.007, 0.060)	<0.001
Yes	1.00	1.00	
Fuel for cooking			
Electricity	0.021 (0.012, 0.037)	4.63x10 ⁻⁶ (7.35x10 ⁻⁷ , 2.9x10 ⁵)	<0.001
Charcoal and wood	1.00	1.00	
Season			
Winter	6.886 (0.519, 91.423)	9.838 (0.08, 1293.8)	0.358
Summer	0.816 (0.594, 1.122)	3822.2 (812.6, 17977.8)	<0.001
Spring	2.030 (1.175, 3.508)	294694 (23273, 3731554)	<0.001
Autumn	1.00	1.00	
Limited daily activities			
Yes	2.076 (1.527, 2.822)	0.479 (0.250, 0.918)	0.027
No	1.00	1.00	
Layout of the kitchen			
Outside the house	1.173 (0.860, 1.599)		
Inside the house	1.00		

Age			
>28	0.615 (0.307, 1.231)	1.103 (0.367, 3.295)	0.861
29-38	0.358 (0.202, 0.634)	1.453 (0.571, 3.698)	0.433
39-48	0.619 (0.345, 1.110)	0.957 (0.376, 2.434)	0.927
>48	1.00	1.00	
Marital status			
Others	3.28 (2.40, 4.47)	0.003 (0.0003, 0.0299)	<0.001
Married	1.00	1.00	
Monthly income			
<6000	0.793 (0.506, 1.242)		
6001-10000	0.804 (0.513, 1.260)		
>10001	1.00		

^a-AOR and p-value cells are blank because the COR value is not significant.

Discussion

This cross-sectional study assessed asthma's magnitude and associated risk factors among adult patients. The findings revealed that 41.8%, 43.5%, and 14.7% have mild, moderate, and severe asthma status, respectively. In contrast, a study conducted in Malaysia showed that 9.9% of the patients had moderate asthma, and 2.7% had severe asthma (21). However, the researchers used the clinical methods recommended by GINA to assess severity. In our study, the severity classification was not according to GINA's recommendation. Most of the patients were diagnosed only with acute exacerbation of asthma. The small number of physicians and the lack of enough training to assess the severity are partly the reasons for not following the recommendation of GINA.

The prevalence of bronchial asthma among adult patients in the selected healthcare centers was 4.3%. However, a study done in the adult emergency room of Addis Ababa Zewditu Memorial Hospital showed a 1.5% prevalence (17)). The prevalence of asthma among adult patients of the United Arab Emirates and Debre Berhan is 13% (22) and 29.6% (17), respectively. Relatively, the severity in our study is lower, which could be because the participants live in high-altitude areas with colder weather.

This study revealed that patients who come from a family with an asthma history are more likely to develop bronchial asthma. Similar findings have been reported in different countries (17, 22). In this study, the educational level of asthma patients is significantly associated with their asthma level. Educated patients have a lower risk of asthma disease because they have a better understanding of minimizing exposure to asthma than those who cannot read and write. However, this is not true in all countries; e.g., a study conducted in the United Arab Emirates (22) showed no association between asthma and the education level of the patients.

Asthma patients from a bad-smelling environment are more likely to develop bronchial asthma; a similar finding was reported in (23). Also, married patients have a lower chance of having severe asthma; howev-

er, patients who discontinued their drug have a higher chance of developing bronchial asthma, which was also reported in other studies (17, 21, 24). Using fuel instead of electricity as a source of energy for cooking significantly increases the chance of having severe asthma, which is consistent with the findings of (23). Charcoal and wood are widely used for cooking, which increases asthma status because they contain pollutants such as carbon monoxide (CO) and sulfur dioxide (SO₂). Therefore, cleaner cooking technologies, such as solar power and electricity, could prevent or reduce asthma and other respiratory illnesses.

Conclusion

The severity of bronchial asthma among adult patients is relatively high. Exercise habits, drug discontinuity, education level, family history of asthma, bad smells around the house, the source of energy for cooking, and marital status increase the risk of bronchial asthma. Most asthma patients are urban dwellers. Most patients were classified as having moderate bronchial asthma, which differs from studies in other countries, highlighting the need for appropriate classification. Since adherence to GINA guidelines for treating and managing patients was low, a national guideline is needed for uniform classification and management of bronchial asthma.

Based on our findings, we recommend the following interventions to reduce the severity of asthma: (a) training and educating people about the significant variables identified in this study, (b) implementing guidelines for classifying asthma based on severity and according to GINA guidelines, and (c) prioritizing environmental hygiene to reduce the severity of asthma.

Acknowledgment

We thank Injibara University for the financial support and the healthcare professionals in the hospitals and the healthcare centers for their help. We also thank the study participants for their participation and for sharing valuable insights.

Consent for publication

Not applicable.

Authors' Contributions

Atalaye Nigussie (A.N.), Belsti Atnkut (B.A.), Gedif Mulat Alemayehu (G.M.A.), and Nigussie Adam Birhan (N.A.B.) prepared the survey tool, and supervised the data collection. A.N., B.A., and Destaw Mullualem (D.M.) conducted data entry to SPSS. A.N., B.A., G.M.A., and Tessema Astatkie (T.A.) analyzed the data. Zelalem Meraf Woldie, A.N. and B.A. wrote the draft manuscript and T.A. revised and prepared the final version of the manuscript. All authors read and approved

the final manuscript.

Conflict of Interest

The authors declare that they have no conflicts of interest.

Funding

Injibara University financed the study.

Data Availability

Data will be made available upon a reasonable request.

References

1. Alamer F, Almuzaini AS, Alharbi S, Algoblan M, Alayed F, Alsaqri RA, Alswed YS. Asthma Prevalence Among Adults in Qassim Region, Saudi Arabia. *Cureus* 2024; 16(1) <https://doi.org/10.7759/cureus.53229>.
2. Masoli M, Fabian D, Holt S, Beasley R. G.I.f.A. Program, The global burden of asthma: executive summary of the GINA Dissemination Committee report. *Allergy* 2004; 59(5): 469 <https://doi.org/10.1111/j.1398-9995.2004.00526.x>.
3. Fentahun S. A Study on the Assessment of Prevalence of Asthma and Factors that Lead Patients to Visit Adult Emergency Room of Zewditu Memorial Hospital, Addis Ababa, 2017. 2017; Addis Ababa University.
4. Adeloje D, Chan KY, Rudan I, Campbell H. An estimate of asthma prevalence in Africa: a systematic analysis. *Croat Med J* 2013; 54(6):519 <https://doi.org/10.3325/cmj.2013.54.519>.
5. Buist AS, Vollmer WM. Reflections on the rise in asthma morbidity and mortality. *JAMA* 1990; 264(13):1719 <https://doi.org/10.1001/jama.1990.03450130091034>.
6. Gupta RS, Weiss KB. The 2007 National Asthma Education and Prevention Program asthma guidelines: accelerating their implementation and facilitating their impact on children with asthma. *Pediatrics* 2009; 123: S193 <https://doi.org/10.1542/peds.2008-2233J>.
7. Tefereedgn EY, Ayana AM. Prevalence of asthma and its association with daily habits in Jimma Town, Ethiopia. *Open J Asthma* 2018; 2(1):011-017 <https://doi.org/10.17352/oja.000009>.
8. Fanta K, Daba FB. Uncontrolled asthma and associated factors among adult asthmatic patients on follow-up at chest clinic of jimma university specialized hospital, south-west Ethiopia. *Pharm Res* 2016; 6(11): 1
9. Wjst M, Boakye D. Asthma in Africa. *PLoS Med* 2007; 4(2): e72 <https://doi.org/10.1371/journal.pmed.0040072>.
10. Sharma S, Sood M, Sood A. Environmental risk factors in relation to childhood asthma in rural area. *Curr Pediatr Res* 2011; 15(1): 29
11. Elfaki N, Shiby A. Risk factors associated with asthma among Saudi adults in Najran. *J Clin Respir Dis Care* 2017; 3(133): 1247 <https://doi.org/10.4172/2472-1247.1000133>.
12. Mekonnen D, Andualem M. Clinical Effects of Yoga on Asthmatic Patients: A Preliminary Clinical Trial, Jimma, Southwest Ethiopia. *Ethiop. J Health Sci* 2010; 20(2)
13. Gebresillasie TG, Worku A, Ahmed AA, Kabeta ND. Determinants of asthma among adults in Tigray, Northern Ethiopia: a facility-based case-control study. *PeerJ* 2024; 12: e16530 <https://doi.org/10.7717/peerj.16530>.
14. Amoah AS, Forson AG, Boakye DA. A review of epidemiological studies of asthma in Ghana. *Ghana Med J* 2012; 46(2): 23.
15. Ait-Khaled N, Enarson D, Bousquet J. Chronic respiratory diseases in developing countries: the burden and strategies for prevention and management. *Bull World Health Org* 2001; 79: 971
16. Sa-Sousa A, Morais-Almeida M, Azevedo LF, Carvalho R, Jacinto T, Todo-Bom A, Loureiro C, Bugalho-Almeida A, Bousquet J, Fonseca JA. Prevalence of asthma in Portugal-The Portuguese National Asthma Survey. *Clin Transl Allergy* 2012; 2(1): 1 <https://doi.org/10.7759/cureus.53229>.
17. Shine S, Muhamud S, Demelash A. Prevalence and associated factors of bronchial asthma among adult patients in Debre Berhan Referral Hospital, Ethiopia 2018: a cross-sectional study. *BMC Res Notes* 2019; 12: 1 <https://doi.org/10.1186/s13104-019-4670-9>.
18. Tadesse BA, Gebreamanule B, Temesgen AN, Tilahun T, Astatkie T. Determinants associated with an effective online learning system of a teachers' training college in Awi Zone, Ethiopia during the COVID-19 pandemic. *Interact Learn Environ* 2023; 1-11 <https://doi.org/10.1080/10494820.2023.2186898>.
19. Yimenu DK, Teni FS, Ebrahim AJ. Prevalence and Predictors of Storage of Unused Medicines among Households in Northwestern Ethiopia. *J Environ Public Health* 2020; 2020: 8703208 <https://doi.org/10.1155/2020/8703208>.
20. Daniel WW. *Biostatistics: a foundation for analysis in the health sciences*. Wiley, 1978.
21. Ngui R, Lim YAL, Chow S, de Bruyne J, Liam C. Prevalence of bronchial asthma among Orang Asli in Peninsular Malaysia. *Med J Malaysia* 2011, 66(1): 27

22. Alsowaidi S, Abdulle A, Bernsen R. Prevalence and risk factors of asthma among adolescents and their parents in Al-Ain (United Arab Emirates). *Respiration* 2009; 79(2): 105 <https://doi.org/10.1159/000219248s>.
23. Woldetsadik MD, Kumie A. Prevalence of symptoms of asthma and associated factors among primary school children in Addis Ababa. *Ethiop Med J* 2018; 56(4) <https://doi.org/10.1159/000219248>.
24. Adams JY, Sutter ME. The Patient with Asthma in the Emergency Department. *Clinic Rev Allerg Immunol* 2012; 43: 14–29 <https://doi.org/10.1007/s12016-011-8273-z>.