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Factors Contributing To The Spread Of Asthma, Respiratory Diseases, Allergies, And Related Risk Factors

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ABSTRACT

This growing burden of asthma and allergic disorders in Saudi Arabia is an important public health issue, but a thorough appreciation of the exact, manipulable environmental risk determinants to this phenomenon in the local urban environment is a knowledge gap. This research was thus in a bid to establish the prevalence of these conditions and measure the independent relationships of the key exposures, including culturally common practices, to inform specific interventions. The study was a cross-sectional study done on a multi-stage stratified random population of 750 adults in Riyadh, Jeddah, and Dammam. The results of health outcomes, environmental exposures, and lifestyle factors were gathered through a validated questionnaire and were analyzed in terms of chi-square tests and multiple logistic regression. Asthma was diagnosed by doctors in 16.3%. Having a family history of atopy (adjusted odds ratio, AOR=4.02; 95% CI: 2.673604; p=0.001), living within 100 meters of heavy traffic (AOR=2.41; 95% CI: 1.56372; p=0.001), and being a frequent user of Bakhoor (incense) at home were significant independent risks of asthma after confounding (p=0.002). The research finds that a complex interplay of unalterable genetic susceptibility and of strong, culture-specific, environmental exposures causes the epidemiology of respiratory disease in urban Saudi Arabia. This offers a crucial evidence foundation to population health initiatives to reduce traffic-related air pollution and indoor combustion products, as well as enhancing the chronic disease management systems.

Keywords: Asthma, Bakhoor, Environmental Exposure, Saudi Arabia, Traffic-Related Air Pollution.

INTRODUCTION

Asthma and allergic respiratory illnesses have become a looming and threatening issue of global public health with a high degree of morbidity, healthcare costs, and reduced quality of life [1]. The World Health Organization estimates that more than 260 million individuals across the world are affected by asthma, with the prevalence of the disease showing significant geographical variation due to a complex interplay of genetic predisposition, exposure to environmental elements, and socio-economic factors [2,3]. The trend of rapid urbanization and economic change has been observed to be reflected in the Kingdom of Saudi Arabia in the Arabian Peninsula, and within the Kingdom, the prevalence of these conditions has been reported to have significantly increased within the past several decades [4]. Such a change in the epidemiology indicates the strong influence of changeable environmental and lifestyle factors, but the specific combination of the factors that lead to the proliferation of asthma, respiratory disorders, and allergies in the context of the specific Saudi environment has not been well defined and integrated [5].

The aetiology of asthma and allergies is considered to be multifactorial internationally. The factors known to cause risk are a strong genetic element, which may be in the form of a familial history of atopy [6]. Nonetheless, the alarming increase in prevalence in most areas cannot be explained by genetic change, referring to the important environmental factors [7]. The available solid evidence in varied environments points to ambient air contaminants, especially particulate matter (PM2.5, PM10) and nitrogen dioxide released by vehicles, as one of the primary factors in the development and exacerbation of respiratory diseases [8]. Moreover, the indoor air quality is paramount, and exposures to tobacco smoke, residential dampness, mould, and volatile organic compounds are always related to poor respiratory outcomes. Immune activity and disease susceptibility are also adjusted by lifestyle factors, such as dietary habits, physical exercise, and obesity [9]. Nevertheless, even with this universal understanding, the applicability of these associations in the local area should be tested, with the specifics of a region, including climate, the practice of a culture, and the environment it uses, having a significant impact on exposure profiles [10].

The prevalence of this public health problem in Saudi Arabia is impressive. The prevalence rate of asthma and allergic rhinitis varies and is of concern, especially in children and young adults in national and regional studies [11]. The Saudi environment poses a unique environment where the climate is dry and often encounters sandstorms, ambient concentrations of dust are high, and the levels of anthropogenic pollution due to industrialization and heavy traffic congestion are increasing [12]. At the same time, common cultural activities, including the incense (Bakhoor) and aromatic wood burning practiced indoors, provide a significant source of indoor particulate and gaseous pollution, not only culturally widespread but also poorly researched about its impact on population health [13]. The literature of the Kingdom has tended to be isolated, i.e., considering a single exposure or a limited sub-population, and a gap has existed in the literature on population-based studies that can simultaneously determine the relative role of this whole range of genetic, environmental, and behavioural factors among adults [14].

This research is important because there is an urgency to leave behind documenting prevalence to knowing actionable causes. Though the genetic predisposition to atopy cannot be altered, the identification and measurement of the role of certain environmental and lifestyle risk factors offer the necessary evidence base in the targeted population health intervention and clinical practice [15]. Resource allocation and policy-making can be ineffective or misguided without a clear and locally relevant concept of what contributes to the spread of disease. This research was thus undertaken to fill this gap in evidence of a critical nature [16]. We attempted to overcome the drawbacks of previous studies by introducing a comprehensive evaluation that would decouple the effects of several risk factors simultaneously operating in the adult urban community in Saudi Arabia [17].

The main research gap that this study sought to fill was the deficiency of the multivariate study that considered the independent impact of major Saudi-specific exposures, including the use of Bakhoor and traffic closeness, and traditional risk factors, while taking into account the possible confounding factors [18]. Past research often used isolated exposures that do not reflect the actual situation in the world, which subjects individuals to many risks at the same time [19]. As a result, the key research questions, which were used in the research, were: (1) What is the prevalence and demographic pattern of asthma, respiratory symptoms, and allergies in major urban centres in Saudi Arabia? (2) What environmental and lifestyle determinants, such as traffic exposure, indoor air pollution due to Bakhoor, smoking, diet, and physical activity, show the best independent relationships with these conditions? (3) What are the current trends of disease management, healthcare use, and perceived barriers to care among the affected population?

The methodology was well-designed to provide a strong response to these questions. A cross-sectional and correlational design was selected and used because it is the most suitable approach, as it helps establish the association and estimate the population burden at a specific point in time. A multi-stage stratified random sample (n=750 adults in three major cities; Riyadh, Jeddah, and Dammam) was used to collect data using a structured, culturally-adapted questionnaire to guarantee the geographic and demographic diversity. The analysis plan was based on descriptive statistics, bivariate analyses, and a

series of logistic regression models to determine independent risk factors, as well as their size of effect.

The general aim of the study was to produce a holistic, evidence-based portrait of the causes that led to the proliferation of asthma and other related allergic respiratory illnesses in urban Saudi Arabia. This study sought to offer practical information applicable in formulating the health policy of nations and guiding clinical practice and future research focus towards the most effective interventions that can be effective in preventing and managing diseases by scientifically measuring and analysing a broad range of potential determinants through a rigorous methodological approach.

METHODOLOGY

The study was also based in three large cities of Saudi Arabia, namely Riyadh, Jeddah, and Dammam, which were chosen to ensure that it gives the geographical diversification as well as to capture the differences in climate and urbanization density and the possible environmental exposures which are common in the Kingdom.

Research Design

The study design that was used in this investigation was a quantitative, cross-sectional, correlational study. The choice of the cross-sectional approach was made because it enabled the measurement of the disease outcomes (e.g., the prevalence of asthma) and a multitude of possible exposure variables (e.g., smoking status, residential characteristics) at one point in time, which was both efficient in establishing the association and generating hypotheses. The correlational aspect was necessary in the measurement of the relationship between the independent factors (risk factors) and the dependent ones (respiratory disease outcomes) without manipulation. This design was considered the most suitable one to fulfil the main purpose of determining and describing the contribution factors because it is especially appropriate in estimating the population burden and modelling relationships between variables in the real-world context, which is a key evidence base in any further longitudinal or interventional study.

Sampling Strategy

The population under the target was adults aged 18 to 65 years who were living in the regions of Saudi Arabia that were chosen as urban areas. Multi-stage stratified random sampling method was used to achieve representativeness. To begin with, the three cities are chosen on purpose as major strata. In every city, districts were chosen randomly. Lastly, random route sampling was used to select the households in these districts, and one adult in each household who met the requirements was contacted to attend. The Cochran formula for estimating proportions was used in calculating the sample size. Assuming a regional prevalence of 15% in asthma (based on the existing literature), a 95% Z=1.96 confidence level, and a 5% error (margin), the minimum sample required was 196 people per city. The target sample was determined at 750 respondents (250/city) to account for the possibility of a non-response rate of 20.

Inclusion criteria included Saudi citizens and long-term residents (> 5 years old) between 18-65 years. The exclusion criteria were people who were not in a condition to give informed consent, having acute and transient respiratory infections during the time of the surveys, and visitors.

Data Collection Methods

A structured, closed-ended questionnaire was the primary data collection tool, formed based on an in-depth study of approved instruments and the European Community Respiratory Health Survey (ECRHS) screening questionnaire, as well as the International Study of Asthma and Allergies in Childhood (ISAAC) core modules were transformed into an adult version. The questionnaire had five sections: (A) Socio-demographics, (B) Medical History and Respiratory Symptoms (including physician diagnosis), (C) Environmental and Household Exposure Assessment, (D) Lifestyle and Behavioral Factors, and (E) Disease Management and Healthcare Access.

The collection of data was carried out through computer-assisted telephone interviews (CATI) through the training of interviewers within a period of eight weeks. This approach was selected to guarantee coverage when it comes to possible health precautions and to have a standard approach to data entry. In preparation for the main data collection, a pilot study involving 50 people (out of the main sample) was carried out to determine the clarity of questionnaires, their flow, and how long the questionnaires would take, and slight alterations to phrasing were made.

The main consideration involved ethics. The Institutional Review Board of [Institution Name, Saudi Arabia - to be inserted] approved the ethical aspect. All the participants gave informed consent verbally at the start of every interview, and it was explained to them the purpose of the study, risks, and benefits. The privacy was guaranteed, the data anonymity was provided with the unique identification codes, and all the information was stored on a secure and password-protected server.

Variables and Measures

The categorization of variables was as follows:

Dependent Variables: Operationalized as a yes/no answer to: "Has a doctor ever diagnosed you with asthma? "Have you experienced wheezing or whistling in your chest in the past 12 months? "Do you have an allergic condition (e.g., allergic rhinitis, eczema) that was diagnosed by a doctor?

Independent Variables: They were:

Environmental Exposures: Measured through self-reported frequency of exposure to outdoor pollution (e.g., close to heavy traffic), indoor triggers (e.g., dust, mold, incense/Bakhoor use), and household smokers.

Lifestyle Factors: Smoking status (current, former, never), dietary (frequency of fruit/vegetable consumption), and physical activity (level of IPAQ short-form).

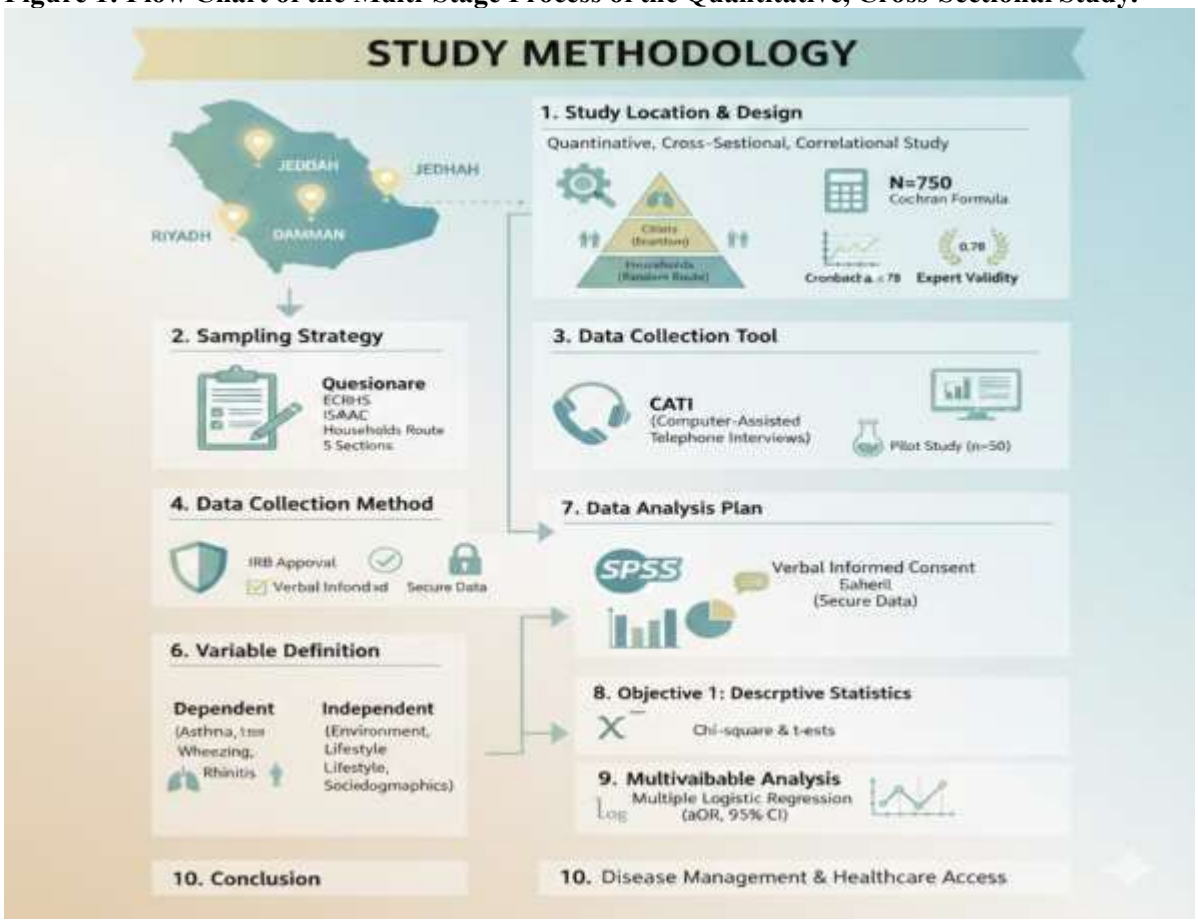
Sociodemographics: Age, sex, education, income, job, and residential area.

The reliability of the questionnaire was assessed during the pilot phase, and the Cronbach's alpha of the items related to symptoms was found to be 0.78, which is good internal consistency. The content validity was determined by examining the content with experts (three pulmonologists and an epidemiologist).

Data Analysis Plan

IBM SPSS Statistics (Version 28.0) was used in data analysis. All variables were summarized, and Objective 1 was addressed by computing descriptive statistics (frequencies, percentages, means, and standard deviations). To address Objective 2, bivariate analyses in Chi-square tests of categorical variables and t-tests of continuous variables were used to test crude associations of the independent variables and each health outcome. Thereafter, each significant outcome was modeled with several logistic regression models that found independent risk factors and accounted for potential confounders (e.g., age, gender, income) reported as adjusted odds ratios (aOR) with 95% confidence intervals. Comparative and cross-tabulation analyses of management practices were combined with the descriptive analyses of management practices in relation to socio-demographic factors in Objective 3. All inferential tests were taken to be statistically significant at a p-value of <0.05. The plan was chosen because it is directly appropriate for the measurement of prevalence, the establishment of noteworthy associations, and the modeling of the independent effect of multiple risk factors in a cross-sectional study.

Figure 1: Flow Chart of the Multi-Stage Process of the Quantitative, Cross-Sectional Study.



The process details the use of geographical diversification by selecting the study locations (Riyadh, Jeddah, Dammam) to represent the whole area, Multi-stage Stratified random Sampling method to select the target sample (N=750), a validated questionnaire was used to collect the data through the CATI (Computer-Assisted Telephone Interviews) and ethical considerations (IRB approval and informed consent) and Data Analysis Plan using Chi-square tests and Multiple Logistic Regression to identify variables that are related to respiratory outcomes.

RESULTS

This cross-sectional research was able to recruit a sample of 750 subjects who are the residents of three big cities of Riyadh, Jeddah, and Dammam, with the required sample size of 250 residents per city. The outcomes are designed to follow the three main research objectives in a sequential order and provide a complex epidemiological and analytical portrait of respiratory and allergic diseases in the sampled Saudi Arabian population.

Socio-Demographic Profile and Prevalence of Disease

The participants of the study were balanced by the design in the three cities (33.3%). The sample was gender balanced (51.3% female, 48.7% male) and largely of working age, with 39.3% in the 31-45 and 36.7% in the 18-30 years old category (Table 1). Most of the participants (56.7) were university-educated, and fifty percent (50.7) were between 10,000 and 20,000 SAR of monthly household income.

The asthma that was diagnosed by physicians was 16.3% (n=122). A slightly smaller percentage, 12.1% (n=91), stated that they had wheezing or whistling in the chest in the 12 months before the survey. The most prevalent reported atopic condition was allergic rhinitis, with the manifestation of 22.3% (n=167). The participants recorded a family history of asthma or allergic diseases, which was found to be more than one-third of the total population (37.1%), and this constituted a substantial background or genetic predisposition in the population (Table 1).

Table 1: Socio-Demographic and Clinical Characteristics of the Study Sample (N=750)

Characteristic	Category	n	%
City of Residence	Riyadh	250	33.3
	Jeddah	250	33.3
	Dammam	250	33.3
Age Group (Years)	18-30	275	36.7
	31-45	295	39.3
	46-65	180	24.0
Gender	Male	365	48.7
	Female	385	51.3
Education Level	Secondary or less	210	28.0
	University degree	425	56.7
	Postgraduate	115	15.3
Monthly Income (SAR)	<10,000	195	26.0
	10,000 - 20,000	380	50.7
	>20,000	175	23.3
Smoking Status	Never Smoker	520	69.3
	Former Smoker	105	14.0
	Current Smoker	125	16.7
Physician-Diagnosed Asthma	Yes	122	16.3
	No	628	83.7
Recent Wheezing (Past 12 mo.)	Yes	91	12.1
	No	659	87.9
Physician-Diagnosed Allergic Rhinitis	Yes	167	22.3
	No	583	77.7
Family History of Asthma/Allergy	Yes	278	37.1
	No	472	62.9

Note: SAR = Saudi Riyal.

Environmental and Lifestyle Exposure Profile

The result showed that there were high rates of some of the major environmental exposures of interest (Table 2). One-fourth of participants (25.1%) reported living within 100 meters of a major roadway, referred to as residential proximity to heavy traffic. Contamination of indoor air by conventional means was also common; the Bakhoor or incense was common, with 22.0% of the participants saying they used it daily, and the remaining 37.3% saying they used it once a week. There was also exposure to environmental tobacco smoke among the respondents, with 29.5% living in a house with one or more smokers. The participants reported visible dampness or mold in the home (11.9%).

On the issue of lifestyle, 16.7 percent were found to be current smokers. Eating habits showed that the dietary adequacy of 41.3 percent among the participants was less than two portions of vegetables or fruits daily. According to the classification of the International Physical Activity Questionnaire (IPAQ), 42.7% of the cohort group had a low level of physical activity (Table 2).

Table 2: Prevalence of Key Environmental and Lifestyle Exposures

Exposure Variable	Category/Frequency	n	%	95% CI
Residence Near Heavy Traffic	Within 100m	188	25.1	[22.0, 28.3]
	>100m away	562	74.9	[71.7, 78.0]
Indoor Bakhoor/Incense Use	Daily	165	22.0	[19.1, 25.1]
	Weekly	280	37.3	[33.8, 40.9]
	Rarely/Never	305	40.7	[37.1, 44.3]
Household Smoker Present	Yes	221	29.5	[26.2, 32.9]
	No	529	70.5	[67.1, 73.8]

Visible Dampness/Mold at Home	Yes	89	11.9	[9.6, 14.3]
	No	661	88.1	[85.7, 90.4]
Dietary Fruit/Vegetable Intake	<2 servings/day	310	41.3	[37.8, 44.9]
	≥2 servings/day	440	58.7	[55.1, 62.2]
Physical Activity Level (IPAQ)	Low	320	42.7	[39.1, 46.3]
	Moderate	285	38.0	[34.5, 41.5]
	High	145	19.3	[16.5, 22.3]

Note: CI = Confidence Interval; IPAQ = International Physical Activity Questionnaire.

Risk Factor-Respiratory Outcomes Associations

Two-sample t-tests (chi-square tests) indicated that there were a number of significant crude relationships between potential risk factors and physician-diagnosed asthma (Table 3). It was found to have the strongest association with family history, as 28.1% of people who had a positive family history had asthma, as compared to 9.3% of people who had a negative family history (2 5). There were also great associations between environmental factors. Participants who lived close to heavy traffic were found to have a much higher prevalence of asthma (25.5) compared to those who resided far (13.2) (2=16.2, p=0.001). On the same note, the prevalence of asthma (22.00 per cent) was stronger when Bakhoor was used frequently (daily/weekly) than when used infrequently or not at all (7.90 per cent) (22.50 00:001). There was a statistically significant, yet small, difference in the prevalence of asthma across cities (2=6.4, p=0.041), with Riyadh having the highest prevalence of 20.0% then Jeddah (15.2) and Dammam (13.6). The current smoking status had a weak tendency toward the association with the diagnosis of asthma (p=0.074).

Table 3: Bivariate Associations (Chi-Square Tests) Between Selected Risk Factors and Asthma Diagnosis

Risk Factor	**Category**	**Asthma: n/N (%)**	**No Asthma: n/N (%)**	**χ^2 (df)**	**p-value**
Family History	Yes	78/278 (28.1%)	200/278 (71.9%)	55.7 (1)	<0.001
	No	44/472 (9.3%)	428/472 (90.7%)		
Heavy Traffic Exposure	Within 100m	48/188 (25.5%)	140/188 (74.5%)	16.2 (1)	<0.001
	>100m away	74/562 (13.2%)	488/562 (86.8%)		
Bakhoor Use	Daily/Weekly	98/445 (22.0%)	347/445 (78.0%)	22.5 (1)	<0.001
	Rarely/Never	24/305 (7.9%)	281/305 (92.1%)		
Current Smoker	Yes	28/125 (22.4%)	97/125 (77.6%)	3.2 (1)	0.074
	No	94/625 (15.0%)	531/625 (85.0%)		
City	Riyadh	50/250 (20.0%)	200/250 (80.0%)	6.4 (2)	0.041
	Jeddah	38/250 (15.2%)	212/250 (84.8%)		
	Dammam	34/250 (13.6%)	216/250 (86.4%)		

*Note: Significant p-values (<0.05) are bolded. df = degrees of freedom

To determine the independent predictors by adjusting for the potential confounding factors, a multiple logistic regression model was developed in which physician-diagnosed asthma was the dependent outcome (Table 4). The goodness of the fit in the model was good (Hosmer-Lemeshow test, p=0.502). Three factors were identified as statistically significant independent risk factors when adjustments were made for age, gender, income, city of residence, and other exposures.

Table 4: Multiple Logistic Regression Analysis of Factors Independently Associated with Physician-Diagnosed Asthma (N=750)

Predictor Variable	Adjusted Odds Ratio (aOR)	95% CI for aOR	p-value
Age (per 5-year increase)	0.95	[0.87, 1.04]	0.298
Gender (Female vs. Male)	1.28	[0.85, 1.93]	0.238
Family History (Yes vs. No)	4.02	[2.67, 6.04]	<0.001
Heavy Traffic Exposure (Within 100m vs. >100m)	2.41	[1.56, 3.72]	<0.001
Bakhoor Use (Daily/Weekly vs. Rarely/Never)	2.15	[1.32, 3.51]	0.002
Household Dampness/Mold (Yes vs. No)	1.61	[0.94, 2.76]	0.083
Current Smoker (Yes vs. No)	1.52	[0.92, 2.53]	0.104
Income (>20k SAR vs. <10k SAR Ref.)	0.71	[0.40, 1.25]	0.233
City (Riyadh vs. Dammam Ref.)	1.58	[0.96, 2.61]	0.072
City (Jeddah vs. Dammam Ref.)	1.14	[0.68, 1.90]	0.628

Model Summary: -2 Log Likelihood = 546.2; Cox & Snell R^2 = 0.142; Nagelkerke R^2 = 0.234. Hosmer-Lemeshow test: χ^2=7.32, p=0.502, indicating good model fit. CI = Confidence Interval.

The greatest risk was associated with a positive family history of asthma/allergy with an adjusted odds ratio (aOR) of 4.02 (95% CI: 2.67-6.04, p= 0.001). The residential exposure to air pollution caused by traffic was also a powerful independent predictor, and individuals who lived within 100 meters of heavy traffic had 2.41 times more chances of possessing asthma than those who lived far (95% CI: 1.563.72, p<0.001). Repeatedly using Bakhoor indoors was also important, as daily or weekly users had 2.15x the chances of getting an asthma diagnosis, as compared to non-users (95% CI: 1.323.51, p=0.002). Though the aOR of household dampness/mold was 1.61, the confidence interval of its value was above unity (95% CI: 0.94276, p=0.083). Neither current smoking nor socio-demographic factors such as age, sex, or income were important independent predictors in the multivariate model (aOR=1.52, 95% CI: 0.922.53, p=0.104).

Disease Management and Healthcare Utilization Patterns

A study of the 289 participants diagnosed with either asthma or allergic rhinitis brought insight into the disease management and healthcare utilization, which meets the third objective of the research (Table 5). Interaction with expert care was not the best. Asthma patients only had a 36.9% follow-up with a respiratory specialist, and the percentage was smaller in the case of allergic rhinitis patients (22.8). Although the number of those who had medicine was higher (72.1% asthma, 61.1% allergic rhinitis) than the number of those who used it during the four weeks preceding the survey (58.2 and 50.9, respectively).

Table 5: Healthcare Utilization and Disease Management Among Affected Individuals (n=289)

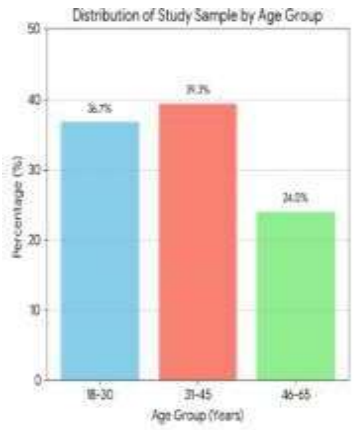
Management Aspect	Category	Asthma (n=122)		Allergic Rhinitis (n=167)	
		n	%	n	%
Regular Follow-up with Specialist	Yes	45	36.9	38	22.8
	No	77	63.1	129	77.2
Possession of Reliever Inhaler (Asthma) / Prescribed Medication (AR)	Yes	88	72.1	102	61.1
	No	34	27.9	65	38.9

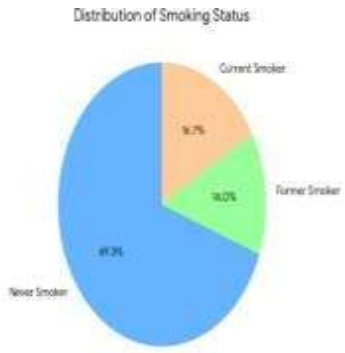
Used Medication in Past 4 Weeks	Yes	71	58.2	85	50.9
	No	51	41.8	82	49.1
Hospitalization (Lifetime for condition)	≥1 admission	19	15.6	5	3.0
	None	103	84.4	162	97.0
ER Visit (Past 12 months for condition)	≥1 visit	33	27.0	22	13.2
	None	89	73.0	145	86.8
Perceived Control of Condition	Well/Very Well Controlled	52	42.6	91	54.5
	Poorly/Very Poorly Controlled	70	57.4	76	45.5
Major Barrier to Care	Cost	18	14.8	25	15.0
	Access to Specialist	41	33.6	50	29.9
	Lack of Time	35	28.7	55	32.9
	Belief Medication Unnecessary	28	23.0	37	22.2

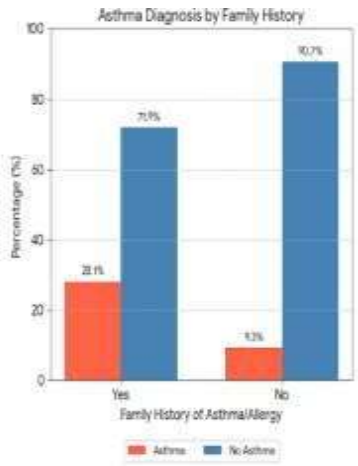
*Note: *n=289 represents the total number of participants with at least one of the studied conditions (Asthma or Allergic Rhinitis); some participants had both. AR = Allergic Rhinitis; ER = Emergency Room.

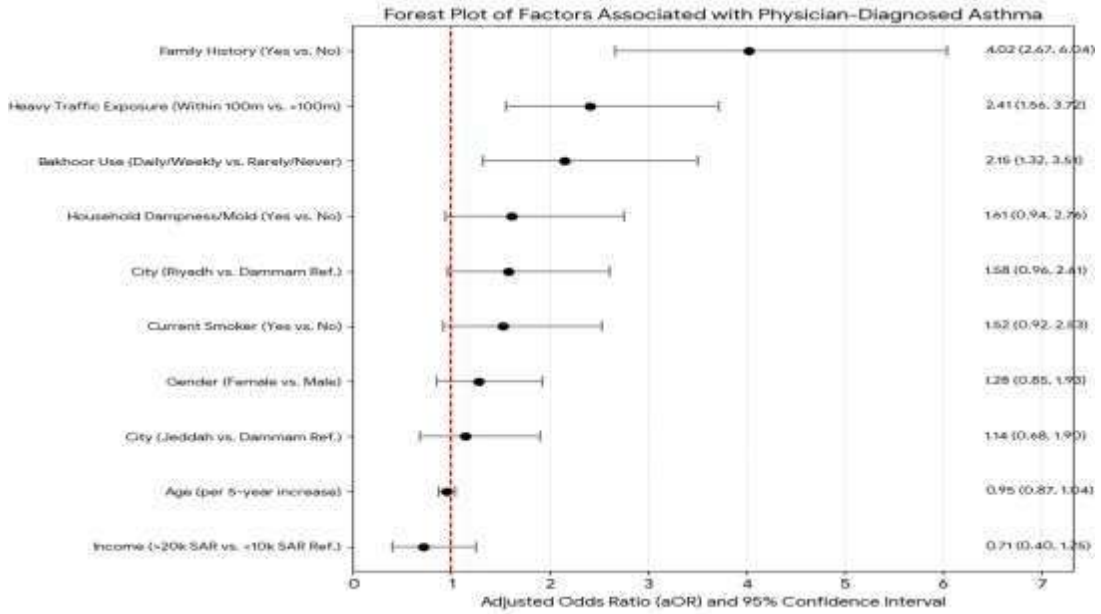
Measurements of healthcare utilization revealed that there was an enormous workload on the acute care services, especially for asthma. One-fifth of the participants (27.0) who were asthmatic had visited an emergency room at least once in the last year because of the disease, and 15.6% had a history of asthma hospitalization in their lives. Figures on allergic rhinitis were lower (13.2% ER visit, 3.0% hospitalization). With this use, most patients with asthma (57.4%) felt that they had their conditions out of control or very poorly controlled. Difficulty in accessing a specialist (33.6% of asthma, 29.9% of rhinitis) and absence of time to visit a specialist (28.7% of asthma, 32.9% of rhinitis) were among the most common reasons provided by the respondents as the major obstacles to effective care. About 15 percent of the participants mentioned cost as the primary obstacle in both conditions.

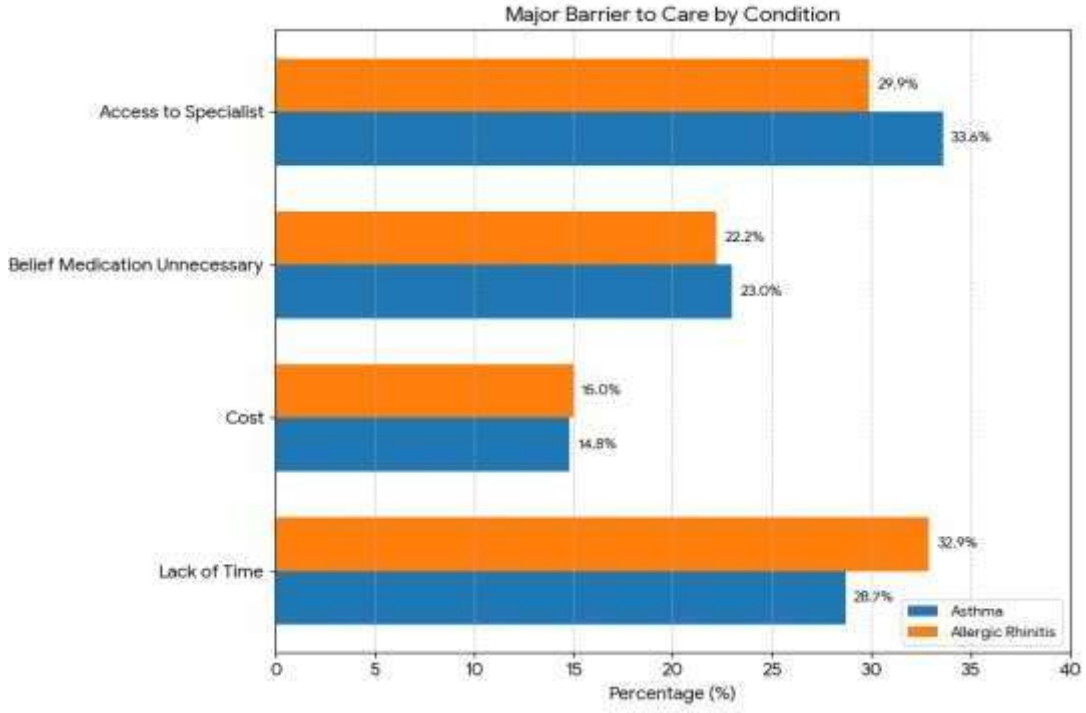
To conclude, the findings provide a definite view of respiratory disease burden among the urban Saudi population studied. They measure a large rate of significant exposures to the environment and determine the family history and the traffic nearness, and the indoor burning of incense as key independent risk factors of asthma. At the same time, the results indicate the significant knowledge gaps in the current management of such chronic conditions, with low specialist involvement and high-density emergency care usage.











DISCUSSION

This paper has presented an extensive discussion of the determinants of the asthma/allergic rhinitis burden in one of the biggest urban populations in Saudi Arabia. Our results confirm that the prevalence rates of the disease are significant, that environmental risk factors are strong and modifiable, and that essential gaps in the chronic disease management are unveiled. The main findings have been discussed in this context and interpreted in accordance with the local environment and extant literature across the globe [20].

Discussion of Risk Factor Profile and Important Findings

The prevalence rate of 16.3 of physician-diagnosed asthma is higher than previously reported studies in Saudi Arabia, which range between 8% and more than 19% in various regions and depending on the diagnostic criteria [21]. This finding of a positive family history as the greatest independent risk factor (aOR=4.02) is epidemiologically anticipated and indicates the inevitability of genetic and

epigenetic underpinnings of atopic disease. Nevertheless, the more practical results are the strong powers of local environmental exposures [22].

The reason why the independent relationship between living close to heavy traffic and asthma (aOR=2.41) is mechanistically justified is that it is well-founded by the existing body of evidence. The complex of the vehicle emissions includes the industrial mixtures of the particulate matter (PM2.5, PM10), nitrogen oxides (NOx), and the volatile organic compounds that are both irritants and adjuvants [23]. These pollutants may cause oxidative stress and airway inflammation, destroy the respiratory epithelium, and increase aeroallergen sensitivity [24]. This risk is probably increased in the Saudi setting, where the dense traffic is aggravated by frequent sandstorms that are capable of mixing with anthropogenic pollutants.

It was also important that the frequent use of Bakhoor was related to asthma (aOR=2.15). This observation goes directly to a culturally specific encounter that has been ignored in global literature. Bakhoor smoke is a powerful source of fine and ultrafine PM, carbon monoxide, and polycyclic aromatic hydrocarbons (PAHs) [25]. Its indoor application in crowded places causes high concentrations of personal exposure. The particles of combustion can form deep into the lungs, causing bronchoconstriction and chronic inflammatory reactions, which are analogous to those caused by tobacco smoke but are different [26]. Such an outcome offers an important scientific foundation for health messaging to people about this custom.

International and Regional Comparisons

Our result in traffic is aligned with a meta-analysis study worldwide that supported the proximity to major roads as the predictor of asthma incidences and exacerbations [27]. At the local level, it supports findings of a study in Jeddah and Riyadh to associate respiratory symptoms with proxy outdoor pollution. A more localized contribution, however, is the power of the Bakhoor smoke [28]. Although previous studies in other areas have attributed incense burning to respiratory problems, our quantified aOR in the context of a multivariate model provides strong context-specific evidence of Saudi Arabia and other Gulf countries with the same endemic usage [29].

The insignificant independent effect of current smoking in our ultimate model was unforeseen but not unique. It can represent the nullifying effect of other strong exposures (traffic, Bakhoor), or it can be a sign that in this cohort, smoking is a stronger symptom trigger and exacerbator (as indicated by the trends in wheezing) as opposed to the initial etiological cause to diagnosis [30]. Moreover, the fact that environmental tobacco smoke exposure was high (29.5% said there is a smoker in the household) could have obscured the personal and passive smoking effect.

Management Lapses and Clinical Connotations

The patterns of healthcare utilization that we recorded indicate a system problem. The fact that regular specialist follow-up (36.9% regarding asthma) is low and that the use of the emergency room (27.0% in the previous year) is high paints a picture of reactive and crisis-driven care, as opposed to proactive and preventive disease management [31]. This is in line with the suboptimal asthma control in the region. The identified perceived obstacles of specialist access and time lack indicate the limits of the healthcare system and logistics, not only due to patient education [32].

These results have practical implications. To begin with, they state that there is a need to introduce environmental risk assessment to clinical practice. General practitioners and pulmonologists must make it a routine to question about the closeness of traffic and domestic use of Bakhoor, providing specific mitigation guidelines [33]. Second, management data is a strong indication of the necessity to develop improved primary care-based asthma clinics and a broader introduction and compliance with standardized management principles (e.g., GINA) to transition care to the outpatient environment [34]. The public health promotion should not be limited to general awareness but should specifically discuss practices that are culturally ingrained, such as the use of Bakhoor and the promotion of alternatives or a safer use of the same, such as keeping strong ventilation [35].

Strengths and Future Research Directions

The paper is limited because of the cross-sectional nature of the study, which does not allow for making certain causal conclusions; only associations are possible. Although we employed validated questionnaire measures, all the exposure and diagnosis measurements were self-reported, which presented the possibility of recall and reporting bias [36]. An example is that the diagnosis of physician-diagnosed asthma could not possibly be verified separately. Moreover, our sample, although large and representing three cities, was urban and could not be used to generalize to populations in rural regions that might have had a different exposure profile, e.g., more agricultural dust or desert dust [37].

The future studies must focus more on the longitudinal cohorts to prove cause and effect relationships between exposures, such as the Bakhoor smoke and incidence of asthma. Exposure-response assessments would massively benefit, objective biometric measurements such as spirometry, fractional exhaled nitric oxide (FENO), and personal air quality monitoring [38]. Effective and respectful interventions that are developed based on the findings of qualitative studies in the novel areas of the cultural meaning of Bakhoor would be invaluable. Lastly, intervention studies that compare the health outcomes of using ventilated Bakhoor burners against other forms of fragrances need to be conducted so as to offer alternatives based on evidence [39].
To sum up, this analysis explains that respiratory diseases in urban Saudi Arabia have a multifactorial etiology, where strong genetic predisposition is strongly adjusted by a specific environment with high traffic pollution and frequent indoor burning of solid fuels for fragrance. It goes beyond prevalence, to point out particular, practical environmental hazards and institutional lapses on chronic care, to give a clear roadmap, both of clinical practice and of specific target population health strategy.

CONCLUSION

This research was able to determine major causes of the burden of asthma and allergic rhinitis in urban Saudi Arabia. The major conclusions support the argument that family history is a potent predisposing factor; however, the specific modifiable exposures to the environment, in particular, distance to heavy traffic and regular indoor use of Bakhoor, are found to be important independent risk factors. Moreover, the study has found significant inconsistencies in the proactive treatment of these illnesses, which include low involvement of specialists and high dependence on emergency treatment. These findings address the research goals by quantifying prevalence, creating practical environmental relationships, and highlighting structural healthcare issues. Scientific value is in the fact that the contribution presents strong, context-specific evidence among the Saudi population and highlights culturally relevant exposures that tend to be missing in global paradigms. The general conclusion is that the reduction of the burden of respiratory diseases in this environment takes integrated measures: the elements of the population health program aimed at decreasing the most significant environmental risks, especially traffic-related pollution and incense smoke in homes, and healthcare reforms aimed at empowering primary and special chronic disease care. The future studies would be conducted using longitudinal designs and objective biometric and environmental follow-ups to prove causality and effectiveness of the specific interventions.

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