Çankırı Karatekin University
Graduate School of Health Sciences

Master of Science Thesis

COMPARISON OF ALLERGIC ASTHMA-RELATED FACTORS ACCORDING TO SOCIOECONOMIC CHARACTERISTICS AMONG CHILDREN AND ADOLESCENTS IN HEALTH CENTERS IN MOSUL, IRAQ

Ahmed Mahdi Saleh SALEH

Advisor

Asst. Prof. Dr. Ceyhun TÜRKMEN

ÇANKIRI 2023

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BY

Ahmed Mahdi Saleh SALEH

The Institute of Health Sciences
The Department of Nursing

The Degree of Master of Science

SUPERVISOR
Asst. Prof. Dr. Ceyhun TÜRKMEN

Çankırı 2023

ACCEPTANCE AND APPROVAL

Ahmed Mahdi Saleh SALEH, the graduate student of The Institute of Health Sciences with the student number of 208205219, has successfully presented her thesis entitled "Comparison of allergic asthma-related factors according to socioeconomic characteristics among children and adolescents in health centers in Mosul, Iraq" before the jury whose signatures are below, after fulfilling all of the requirements determined by the relevant regulations for the degree of Master of Science:

Advisor **:** Asst. Prof. Dr. Ceyhun TÜRKMEN

Co-Advisor **:** Asst. Prof. Dr. Name SURNAME

Examining Committee Members:

Chairman **:** Asst. Prof. Dr. Ceyhun TÜRKMEN
Faculty of Health Sciences Department of Ergotherapy
Çankırı Karatekin University

Member **:** Assoc. Prof. Dr. Zeliha ERTEN KAYA
Faculty of Health Sciences Department of Nursing
Nuh Naci Yazgan University

Member **:** Asst. Prof. Dr. Nilay ŞAHİN
Faculty of Health Sciences Department of Ergotherapy
Çankırı Karatekin University

Approved for the Graduate School of Health Sciences

Assoc. Prof. Dr. Nazan KAYTEZ
Director of Graduate School

ETHICS STATEMENT

The thesis entitled "Comparison of allergic asthma-related factors according to socioeconomic characteristics among children and adolescents in health centers in Mosul, Iraq" which was prepared and presented as a thesis, was written by myself and in accordance with the scientific, academic rules and ethical conduct. The idea/hypothesis of my thesis solely belongs to my supervisor and to me. The research pertaining to the thesis was conducted by myself and therefore, all of the used sentences and interpretations within the work belongs to me.

I declare the aforementioned issues to be correct.

Signature

…../……/2023

Ahmed Mahdi Saleh SALEH

SUMMARY

COMPARISON OF ALLERGIC ASTHMA-RELATED FACTORS ACCORDING TO SOCIOECONOMİC CHARACTERİSTICS AMONG CHILDREN AND ADOLESCENTS IN HEALTH CENTERS IN MOSUL, IRAQ

Ahmed Mahdi Saleh SALEH
Master of Science in Nursing
Advisor: Asst. Prof. Dr. Ceyhun TÜRKMEN
May 2023

In health facilities in Mosul, Iraq, the study's objective is to investigate and analyze the effects of various socioeconomic parameters, such as age, gender, socioeconomic status, level of education, etc., on elements connected to allergic asthma (AA) in young people. This study examined the prevalence of asthma and related risk factors in 290 children and adolescents with asthma aged 6 to 17 years who received medical care in these healthcare facilities. The International Study of Asthma and Allergies in Childhood (ISAAC) scale was used to measure the prevalence and severity of asthma and associated risk factors, and a personal information form was used to collect socioeconomic data. Assuming a significance level of $P<0.05$, the obtained data were analyzed using SPSS software using various statistical procedures including frequency, percentage, mean, standard deviation, ANOVA and independent samples t-test. According to the study, nose symptoms were more severe in children aged 11 to 14 than in those aged 6 to 10 and 15 to 17 ($p=0.001$) and in smokers ($p<0.001$). Children aged 6 to 10 and 11 to 14 had more skin problems than those aged 15 to 17 ($p<0.001$), and smokers had more skin problems ($p<0.001$). Asthma symptoms were more severe in those aged 11 to 14 than in those aged 6 to 10 ($p<0.001$) and 15 to 17 ($p<0.001$). Smokers showed higher prevalence and severity of asthma and allergy symptoms ($p<0.001$), as did adolescents from higher socioeconomic statuses. Asthma and allergy symptoms were more common and severe among smokers as well. Smokers had higher prevalence and severity of these symptoms ($p<0.001$), and

children aged 6 to 10 had more severe specific asthma and allergy symptoms than children aged 15 to 17 ($p<0.001$) and 11 to 14 ($p=0.046$), respectively. Smokers had higher incidence and severity of these characteristics ($p<0.001$), and these factors were more severe in children aged 6 to 10 compared to those aged 11 to 14 and 15 to 17 ($p<0.001$). In conclusion, this study highlights the impact of various socioeconomic parameters on allergic asthma in young individuals in Mosul, Iraq. The findings demonstrate that nose and skin symptoms, as well as asthma severity, were influenced by age, smoking status, and socioeconomic status. These results emphasize the importance of considering these factors when managing allergic asthma in children and adolescents. Targeted interventions and preventive measures tailored to specific age groups, addressing smoking habits, and addressing socioeconomic disparities are recommended for effective asthma management.

2023, 84 pages

Key words: Allergic asthma, Health facilities, Iraq, Risk factors, Socioeconomic parameters

ÖZET

IRAK'IN MUSUL KENTİNDEKİ SAĞLIK MERKEZLERİNDE ÇOCUK VE ERGENLER ARASINDA SOSYODEMOGRAFİK ÖZELLİKLERE GÖRE ALERJİK ASTIMLA İLİŞKİLİ FAKTÖRLERİN KARŞILAŞTIRILMASI

Ahmed Mahdi Saleh SALEH
Hemşirelik, Yüksek Lisans
Tez Danışmanı: Dr. Öğr. Üyesi Ceyhun TÜRKMEN
Mayıs 2023

Bu çalışmada, Irak'ın Musul şehrindeki sağlık tesislerinde, gençler arasında allerjik astım (AA) ile bağlantılı unsurlar üzerinde yaş, cinsiyet, sosyoekonomik durum, eğitim düzeyi gibi çeşitli sosyoekonomik parametrelerin etkilerini araştırmak ve analiz etmek amaçlanmaktadır. Bu çalışma, sağlık tesislerinde tıbbi bakım alan 6 ila 17 yaş arası 290 astımlı çocuk ve ergenin astım yaygınlığı ve ilişkili risk faktörlerini inceledi. Astım ve ilişkili risk faktörlerinin yaygınlığı ve şiddeti ölçmek için Uluslararası Çocukluk Astım ve Alerjileri Çalışması (ISAAC) ölçeği kullanıldı ve sosyoekonomik verileri toplamak için kişisel bilgi formu kullanıldı. Anlamlılık düzeyi $P<0.05$ olarak kabul edilerek, elde edilen veriler SPSS yazılımı kullanılarak frekans, yüzde, ortalama, standart sapma, ANOVA ve bağımsız örneklem t-testi kullanılarak analiz edildi. Bu çalışmanın bulgularına göre, 11 ila 14 yaş arasındaki çocuklar, 6 ila 10 yaş arasındakiler ve 15 ila 17 yaş arasındakilere göre daha fazla burun sorunu yaşıyordu ($p<0.001$). Burun sorunları cinsiyetten önemli ölçüde etkilenmedi ($p=0.116$). Burun sorunları, gelir düzeyinin yeterli veya yetersiz olmasından önemli ölçüde etkilendi ($p<0.001$). Önceki hastalıklar ve aile büyüklüğü burun sorunlarını anlamlı bir şekilde etkilemedi ($p=0.322$). Ancak, sigara içenler, sigara içmeyenlere göre burun sorunlarında daha yüksek puan aldı ($p<0.001$). Bulgular, çeşitli yaşlardaki astımlı ergenlerin farklı derecelerde cilt sorunlarına sahip olduklarını gösterdi. 15-17 yaş arasındakilere kıyasla, 6-10 ve 11-15 yaş arasındaki çocuklar daha yüksek cilt sorunlarına sahipti ($p<0.001$). Cinsiyete bağlı olarak, ergenlik

çağındaki erkek ve kadın astımlılar arasında cilt sorunlarında anlamlı bir farklılık görülmedi (p=0.112). Farklı sosyoekonomik arka planlardan gelen astımlı çocuklar ve ergenler de farklı derecelerde cilt sorunlarına sahipti. Yeterli maddi duruma sahip olan çocuklar ve ergenler, maddi durumu yetersiz olanlardan daha fazla cilt sorunlarına sahipti (p<0.001). Astımlı ergenler arasında aile büyüklüğü cilt sorunlarını anlamlı bir şekilde etkilemedi (p=0.080). Astımlı ergenlerde önceki hastalıklar cilt sorunlarını anlamlı bir şekilde etkilemedi (p=0.086). Ancak, sigara içme cilt sorunlarında önemli bir fark yarattı. Sigara içen astımlı ergenler, sigara içmeyenlere göre daha yüksek cilt sorunları yaşadı (p<0.001). Çalışmanın bulgularına göre, 11-14 yaş arasındaki çocuklar, 6-10 yaş arasındakilere göre (p<0.001) ve 15-17 yaş arasındakilere göre (p<0.001) daha şiddetli astım semptomları gösterdi. Astımlı ergenler arasında cinsiyet ve alerji semptomları açısından anlamlı bir fark yoktu (p=0.059). Farklı ekonomik statülere sahip çocuklar ve ergenler, astım ve alerji semptomlarının yaygınlığı ve şiddeti konusunda farklı düzeylerde deneyim yaşadılar ve daha yüksek ekonomik statüye sahip olanlar daha fazla yaygınlık ve şiddet gösterdi (p<0.001). Aile büyüklüğü, astım ve alerji semptomlarının yaygınlığı ve şiddeti üzerinde anlamlı bir etkiye sahip değildi (p=0.213). Önceki hastalıklar, astım ve alerji semptomlarının yaygınlığı ve şiddeti üzerinde anlamlı bir etkiye sahip değildi (p=0.121). Ancak, sigara içme astımlı ergenlerde astım ve alerji semptomlarının yaygınlığı ve şiddeti üzerinde önemli bir etkiye sahipti ve sigara içen astımlı ergenler, sigara içmeyenlere göre daha yüksek yaygınlık ve şiddet düzeyine sahip oldular (p<0.001). Çalışmanın bulgularına göre, 6 ila 10 yaş arasındaki çocuklar, 15 ile 17 yaş arasındaki çocuklardan (p=0.001) ve 11 ile 14 yaş arasındaki çocuklardan (p=0.046) daha şiddetli özel astım ve alerji semptomları sergiledi. Ayrıca, 15-17 yaş grubundakilere göre, 11-14 yaş grubundaki çocuklar daha şiddetli belirli astım ve alerji semptomları gösterdi (p=0.002). Astımlı ergenler arasında cinsiyete bağlı olarak özel astım ve alerji semptomları açısından önemli bir farklılık bulunmadı (p=0.932). Belirli astım ve alerji semptomlarının yaygınlığı ve şiddeti, farklı sosyoekonomik arka planlara sahip ergenler arasında değişiklik gösterdi ve daha yüksek sosyoekonomik statü hem daha yüksek yaygınlık hem de şiddetle ilişkilendirildi (p<0.001). Dört veya daha fazla üyeli ailelere göre, üç veya daha az üyeli ailelerin belirli astım ve alerji semptomları yaşama olasılığı daha yüksekti (p=0.019). Astımı olan çocuklar ve ergenlerde belirli astım ve alerji semptomları önceki hastalıklardan önemli ölçüde etkilenmedi (p=0.719). Bununla

birlikte, sigara içme önemli bir etkiye sahipti; sigara içen astımlı ergenler, sigara içmeyenlere göre belirli astım ve alerji semptomlarının yaygınlığı ve şiddetinde daha yüksek düzeyde bulundu ($p<0.001$). Çalışma sonuçlarına göre, 6-10 yaş grubundaki çocuklar, 11-14 yaş grubundakilere ($p<0.001$) ve 15-17 yaş grubundakilere ($p=0.002$) göre mevcut hırıltı ile ilişkili faktörler açısından daha şiddetli belirtiler sergiledi. Astımı olan erkek ve kız ergenler arasında mevcut hırıltı ile ilişkili faktörler açısından önemli bir farklılık bulunmadı ($p=0.099$). Farklı ekonomik arka planlardan gelen çocuklar ve ergenler, mevcut hırıltı ile ilişkili faktörlerin farklı düzeylerini deneyimledi ve daha yüksek ekonomik statüye sahip olanlar daha yüksek yaygınlık ve şiddete sahipti ($p<0.001$). Aile büyüklüğü, astımı olan çocuklar ve ergenler arasında mevcut hırıltı ile ilişkili faktörleri önemli ölçüde etkilemedi ($p=0.863$). Önceki hastalıklar, astımı olan çocuklar ve ergenlerde mevcut hırıltı ile ilişkili faktörleri önemli ölçüde etkilemedi ($p=0.285$). Bununla birlikte, sigara içme önemli bir etkiye sahipti; sigara içen astımlı ergenler, sigara içmeyenlere göre mevcut hırıltı ile ilişkili faktörlerin yaygınlığı ve şiddetinde daha yüksek düzeyde bulundu ($p<0.001$). AA'nın, sağlık hizmetlerini arayan çocuklar ve ergenler arasındaki yaygınlığını daha iyi anlamak için bu çalışma, Musul, Irak'taki sağlık merkezlerini ziyaret eden çocuklar ve ergenler arasında AA'nın görülme sıklığına ve demografik bilgilerle ilişkisine baktı. Çalışma, neredeyse tüm çocukların ve ergenlerin burun sorunları olduğunu ve önemli bir kısmının cilt sorunları olduğunu belirtti, astım sorunlarının şiddeti ise oldukça düşüktü. AA'ya sahip çocuklar ve ergenler, yaşlarına, sigara içme durumlarına ve maddi durumlarına bağlı olarak astım ve alerji semptomlarını daha sık ve daha şiddetli yaşadılar. Bu çalışmanın sonuçları, Musul, Irak'taki sağlık personelinin çocuklar ve ergenler arasında AA'yı önlemesine ve yönetmesine yardımcı olabilir. Bu popülasyonda AA ve risk faktörleri hakkında daha kapsamlı bir anlayış sağlamak için daha fazla araştırmaya ihtiyaç duyulmaktadır. Çalışmanın bulgularına göre, Musul, Irak'taki sağlık tesisleri, çocuklar ve ergenler arasında alerjik astımın görülme sıklığını ve şiddetini azaltmak için önlem almalıdır. Bu, sağlıklı yaşam tarzı davranışlarını teşvik etmek, alerjik astımın erken teşhis ve tedavisinin önemini halka duyurmak ve astımın nedenlerini ve tetikleyicilerini öğretmek yoluyla başarılabilmektedir. Ayrıca, astım ve alerjisi olan çocukların ve ergenlerin sağlığını izlemek için rutin muayeneler ve takip tedavisi sunmak önemlidir. Daha yüksek sosyoekonomik arka planlardan gelen ergenlerdeki alerjik astımın yaygınlığını ve

şiddetini etkileyen faktörlerin belirlenmesi ve ele alınması da önemlidir. Bunlar, hava kalitesini artırmak, iç mekân ve dış mekânda allerjenlere maruziyeti azaltmak ve sağlıklı yaşam koşullarını desteklemek için adımlar atmayı içerebilir. Sağlık tesisleri, astım ve alerji yaygınlığını azaltmaya yönelik hedeflenmiş tedavilerin oluşturulması ve uygulanması konusunda düşünmelidir. Çalışma ayrıca Iraklı çocuklar ve ergenler arasında alerjik astımın yaygınlığı ve görülme sıklığı hakkında daha fazla analiz yapılmasının gerekliliğine vurgu yapmaktadır. Gelecekteki araştırmalar, alerjik astım gelişimine yol açan kesin risk faktörlerini belirlemeye ve durumun yaygınlığını ve şiddetini azaltmaya yönelik tedavilerin etkinliğini değerlendirmeye odaklanabilir. Genel olarak, çalışmanın sonuçları, Irak ve alerjik astımın çocuklar ve ergenlerde benzer sorunlarla karşılaşan diğer ülkeler için politika ve sağlık hizmetleri açısından önemli sonuçları içermektedir.

2023, 84 sayfa

Anahtar Kelimeler: Alerjik astım, Sağlık tesisleri, Irak, Risk faktörleri, Sosyoekonomik parametreler

PREFACE AND ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to Asst. Prof. Dr. Ceyhun TÜRKMEN for his directives to finish this work I also dedicate this work to my father and mother

This study was funded by the Ahmad Mahdi SALEH SALEH under the project Prevalence of asthma and related factors among Adolescenceescents in health centers in Mosul, Iraq

Ahmed Mahdi Saleh SALEH
Çankırı-2023

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%	Percent sign
℃	Degree centigrade
SD	Standard deviation

LIST OF ABBREVIATIONS

AA	Asthma
ATS	American Thoracic Society
DALY	Disability adjusted life year
ERS	European Respiratory Society
GERD	Gastroesophageal reflux disease
ICS	Inhaled corticosteroids
IgE	Immunoglobulin E
LCA	Latent class analyses
NLP	Natural language processing
PAC	Predetermined asthma criteria
PSA	Problematic severe asthma
WHO	World Health Organization
ISAAC	International Study of Asthma and Allergies in Childhood
FEV1	Forced expiratory volume in the first second
PVC	Polyvinyl chloride
VOC	Volatile organic compound
STRA	Severe therapy-resistant asthma
DA	Difficult-to-treat asthma
QOL	Quality of life

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1. INTRODUCTION

1.1. History of allergic asthma

According to Nunes et al. (Nunes *et al.* 2017), allergic asthma (AA) is a significant cause of morbidity around the world, including in Canada. Its prevalence has also been rising in many other nations. According to the Asthma Society of Canada (Asthma Society of Canada 2011), Canada has likewise seen an increase in AA cases over the previous 20 years. Despite the fact that the precise origin of rheumatoid arthritis is still unknown, risk factors like age, gender, and inheritance are thought to contribute. Additionally, a number of environmental triggers—internal and external—as well as illnesses that can predispose people, such atopy, are thought to have a role. AA is one of the most prevalent chronic disorders in children and has a large social impact. Geographically, there are differences in the frequency of AA in childhood, with rural children having lower rates than their urban counterparts; however, the causes of this discrepancy are largely understood (Lawson *et al.* 2011).

Differences that occur geographically and among special groups, especially children, must be understood in light of accessibility to healthcare facilities, human exposure to environmental elements, targeted issues, healthy habits, and personal considerations. Gradations between urban and rural areas accentuate these discrepancies, which must be taken into account. It is imperative to do research to understand these variations, but sadly, not many have been done, particularly in the case of allergic asthma (AA) in children, which is a serious problem (Lawson *et al.* 2011).

1.2. Allergic asthma epidemiology

According to Lim et al. (Lim *et al.* 2010) and Papadopoulos et al. (Papadopoulos *et al.* 2012), there is a high correlation between maternal inheritance and the heritability of AA. Smoking and air pollution exposures during pregnancy have been linked to the development of AA (Bornelöv *et al.* 2013). The interaction of hereditary and

environmental variables adds to the disease's complexity. Air pollution and exposure to secondhand smoke are well-known environmental risk factors. Socioeconomic status is also associated with a higher risk of developing AA, perhaps as a result of variations in lifestyle factors and access to healthcare. Additionally, according to Kull et al. (Kull *et al.* 2010), breastfeeding for four or more months appears to lower the risk of developing childhood AA. Overall, there are many potential risk factors contributing to the complex etiology of AA.

AA is known to manifest throughout childhood, and childhood obesity and overweight are associated with the disease's emergence (Ekstrom *et al.* 2017). Although living with siblings is linked to early wheezing episodes, it is also linked to a reduced risk of childhood AA development (Beasley *et al.* 2015). There is a great deal of discussion surrounding the link between owning pets, particularly exposure to cats and dogs, and the risk of or protection against getting AA (Lodrup-Carlsen *et al.* 2012). The atopic march, which describes the progression of allergic illnesses, starts with eczema in infancy, moves through food allergy, and ends with rhinitis and AA later in infancy (Ballardini et al. 2016, Goksör *et al.* 2016, Khan *et al.* 2018, Akar-Ghibril *et al.* 2020). As allergy co-morbidities, AA, eczema, and rhinitis frequently co-occur (Garcia-Aymerich *et al.* 2015). Genetic and environmental factors that are connected through both IgE-associated and non-IgE-associated processes are common to allergic disorders (Anto *et al.* 2017).

IgE-related processes underlie around half of those with AA, whilst non-IgE-related mechanisms are present in the other half. The immune system's hyperreactivity to environmental allergens that are generally innocuous characterizes IgE-associated processes. IgE antibodies specific to a particular allergen are present in people with allergic sensitization (Rindsjö *et al.* 2010). International variations in children's AA symptom prevalence have decreased in recent years; symptoms have increased in formerly low prevalence countries while decreasing in Western Europe (Global Initiative for Asthma 2020). The prevalence of AA symptoms is rising in Eastern Europe, Asia, Latin America, and Africa. Based on a written questionnaire asking 13 and 14-year-olds if they had experienced chest wheezing or wheezing in the previous year, the prevalence

of wheezing worldwide was calculated between 2000 and 2003. According to Lai et al. it was approximately 14% prevalent (Lai *et al.* 2009).

Boys typically demonstrate the highest prevalence of AA throughout early childhood, but girls typically do so after puberty (Almqvist *et al.* 2008, Pignataro *et al.* 2017, Stridsman *et al.* 2017, Keller *et al.* 2018). The causes of this phenomena are unknown, however gender differences in the size of the lungs and airways during infancy may be a significant factor (Global Initiative for Asthma 2020). Hormonal changes and gender differences in environmental exposures, such as smoking, are further potential causes for this gender shift (Almqvist *et al.* 2008). In comparison to men, females might also receive less treatment and less accurate diagnoses. As some forms of AA may remain from childhood into adulthood while others are linked to a higher risk of remission, it is difficult to predict who will have remission and who will have persistent AA (Garden *et al.* 2016, Fuchs *et al.* 2017). Epidemiological studies have shown that chronic AA symptoms are correlated with a familial history of AA and atopy, comorbidity, pulmonary function deficits, and childhood illnesses (Grad *et al.* 2012, Rönmark *et al.* 2016, Fuchs *et al.* 2017). Additionally, whereas severe AA is more likely to continue, mild AA frequently resolves (Sears *et al.* 2015; Fuchs *et al.* 2017).

1.3. Allergic asthma in Iraq

The unusual environment of Iraq, which is characterized by high humidity and dryness and which is the two main elements that contribute to allergies, especially respiratory allergies and disorders, is said to be the reason why allergies are common among Iraqis. Shortness of breath patients have been quite concerned about recent sandstorms, especially since the condition has spread to include dust waves all year round rather than just occurring during certain months.

Although accurate statistics on the number of asthma and allergy sufferers in Iraq are lacking, observations suggest that their numbers have been rising recently. Approximately 211,111 people have been diagnosed with asthma today, and they get treatment in hospitals or through emergency care. These individuals have access to primary care facilities in a range of 51% to 81%, which can help them with their asthma problems. Contrary to popular assumption, a map of these facilities is available for Iraqis to use when they begin to exhibit asthma symptoms (U.S. Agency for International Development 2020).

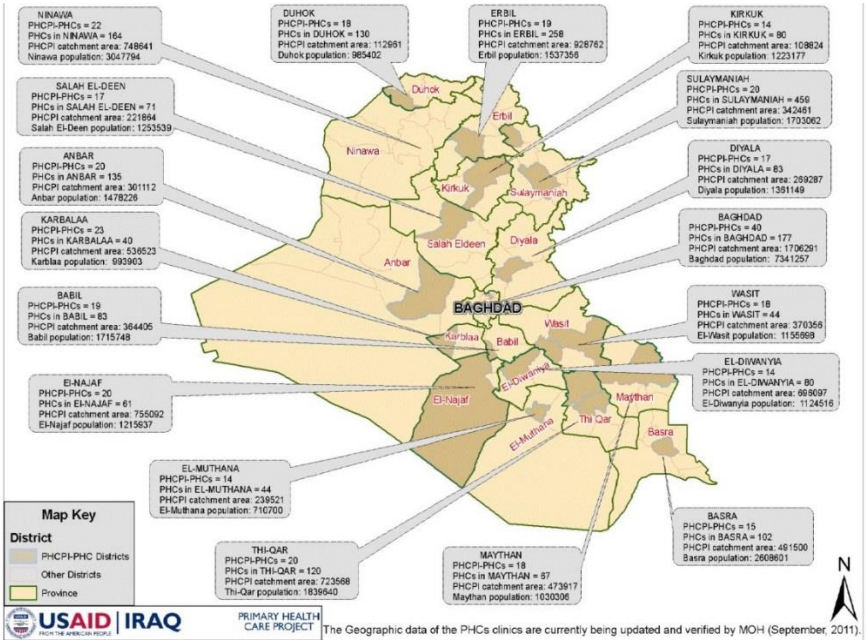

Figure 1.1 Asthma in Iraq (U.S. Agency for International Development 2020).

According to the most recent WHO data from 2020, 62% of all deaths—or 914 deaths—occurred in Iraq, mostly from AA. It's crucial to remember that this statistic could change. According to the 2020 World Health Rankings, Iraq has the 68th-lowest age-adjusted death rate in the world with a rate of 15.5 deaths per 100,000 people (World Health Rankings 2020).

1.4. Objective

In health facilities in Mosul, Iraq, the study's objective is to investigate and analyze the effects of various socioeconomic parameters, such as age, gender, socioeconomic status, level of education, etc., on elements connected to allergic asthma in young people. In order to discover potential disparities, risk factors, or patterns that could guide healthcare strategies, interventions, and policy-making linked to allergic asthma in this community, the study compares these variables across various socioeconomic categories.

1.5. Study questions

What differences exist in the socioeconomic traits of age, gender, socioeconomic class, and educational attainment among children and adolescents with allergic asthma in Mosul, Iraqi health centers?

Based on socioeconomic traits, are there differences in the severity and signs of allergic asthma among children and adolescents in Mosul, Iraq's health centers?

How might the results of this study, taking socioeconomic factors into account, inform healthcare strategies, interventions, and policy-making to address allergic asthma-related factors among children and adolescents in Mosul, Iraq?

2. GENERAL INFORMATION

2.1. Definition of adolescence and children

The term "adolescence" refers to the stage of development during which a person undergoes physical, psychological, or both types of growth. It is derived from the Latin word "Adolescentia," which means "to mature." Between the well-known milestone of puberty and the age of majority, this developmental stage occurs (WHO 2021). While pre-adolescence is particularly common in girls and is frequently connected with adolescence, some signs of adolescence can begin earlier, such as cultural, psychological, or physical changes (Blakemore *et al.* 2010). Males may continue to develop physically and mentally well into their early 20s. Age is a general indicator of adolescence as a result, and experts have disagreed on how to define this developmental stage (Mueller *et al.* 2009).

It takes knowledge from several fields, including psychology, biology, history, sociology, education, and anthropology, to fully comprehend adolescence in society. Adolescence is typically seen as a moment of transition between childhood and adulthood, with the societal goal of preparing people from a variety of angles for adult duties. Schooling, training, employment, unemployment, and changes in living arrangements are among the key changes that are happening throughout this time. According to Patton et al. (Patton *et al.* 2008), different countries experience adolescence and adulthood transitions at different times.

Adolescence is characterized physiologically by the beginning of puberty, the cessation of physical growth, changes in the sex organs, height, weight, and muscle mass, as well as substantial changes in the organization and structure of the brain. Contrary to popular opinion, cognitive development during this stage includes a rise in knowledge as well as the capacity for abstract thought and better reasoning (Schulz *et al.* 2009).

The transitional period between childhood and adulthood, known as adolescence, usually lasts from thirteen to twenty-five years, though certain individuals, cultures, and genders may have different start and end dates. In many contexts, females typically mature before males do. Adolescence can begin at the age of thirteen and last until the age of nineteen or, in rare situations, at the age of fifteen and last until the age of twenty-five (WHO 2021). However, different cultures have different definitions of this era of life, with some societies classifying those under the age of eighteen as children and others classifying people in their early twenties as young adults (WHO 2021).

2.2. Asthma in adolescence and children

2.3.1. AA definition

A chronic inflammatory disease of the airways, asthma affects various cell types and organ systems. This inflammation is linked to bronchial hyperresponsiveness, which causes recurring attacks of coughing, chest tightness, wheezing, and shortness of breath, especially at night and in the early morning. As seen in Figure 2.1, these episodes are accompanied by reversible airflow blockage, which can get better on its own or with therapy (Singh *et al.* 2016).

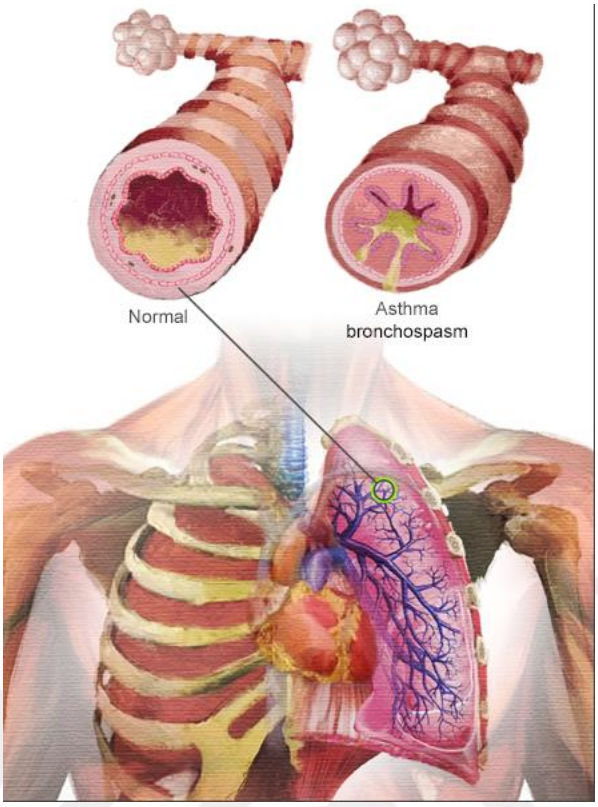

Figure 2.1 The respiratory system of a person with AA (Chest Heart and Stroke Scotland 2022).

With symptoms including chest tightness, dyspnea, wheezing, and coughing, asthma is defined by reversible airway blockage, airway hypersensitivity to direct or indirect stimuli, and expiratory airflow. According to the Global Initiative for Asthma (Global Initiative for Asthma 2020), it is a chronic inflammatory airway illness that involves several different cell types, including mast cells, eosinophils, and T lymphocytes. Airflow restriction and symptom severity can change over time and are frequently influenced by elements including illnesses, exercise, weather, and triggers like allergens (Matsunaga *et al.* 2015).

With periodic episodes of worsening and improving symptoms, asthma symptoms are frequently unpredictable. They typically get worse at night and after physical activity. During asthma episodes, there is a cycle of aggravation in which patients experience wheezing and lung function tests, which worsens the results and lowers peak expiratory flow rate with an obstructive pattern. While persistent asthma may exist in patients with or without wheeze and evidence of hyperinflation, patients may not experience objective

asthma symptoms outside of acute attacks (British Guideline on the Management of Asthma 2016, Global Initiative for Asthma 2020).

The different forms of asthma, the distinctions between childhood and adult asthma, the severity of asthma, and the impact of age on the occurrence and presentation of asthma must all be defined in order to understand the epidemiology, pathophysiology, and etiology of the disease. Asthma phenotypes come in a wide variety, including allergic and non-allergic varieties, which further complicates the common criteria used in several research conducted in various locations (Baptist *et al.* 2013). 122 previously published studies have employed about 60 distinct definitions of childhood asthma, despite efforts to create a single definition through agreement in epidemiological studies (Van Wonderen *et al.* 2010).

The prevalence estimates and risk variables discovered by studies can be affected by asthma because it is a complicated disorder with multiple definitions (Van Wonderen *et al.* 2010). According to studies, there is generally good agreement between four widely used definitions (Van Wonderen *et al.* 2010). To classify asthma incorrectly, some epidemiological definitions—such as current asthma defined as "wheezing breathing in the last 12 months without a cold"—are more sensitive than others (Dharmage *et al.* 2019).

Depending on the clinical criteria being employed, which could include objective measurements such bronchial hyperactivity (Dharmage *et al.* 2019), the prevalence of asthma varies. Age is another essential consideration, especially when determining whether a young child has real asthma vs temporary wheeze brought on by viral illnesses. Early children wheezing episodes may be early asthma symptoms, making a proper diagnosis of the condition more challenging (Burgess *et al.* 2006). Retrospective reviews may also be prone to recall bias, which can cause delayed-onset asthma to be mistaken for childhood asthma (Burgess *et al.* 2006). Therefore, when conducting studies on asthma epidemiology, it is crucial for researchers to pay close attention to the definitions they use and the age of their participants. By doing this, they can increase the precision of their research and comprehend this complicated issue better.

For more individualized treatment based on the endotype a patient is diagnosed with, researchers have proposed the idea of "AA endotypes" as a way to identify distinct subgroups of patients with comparable clinical manifestations but different underlying pathophysiological mechanisms (Lotvall *et al.* 2011, Pavord *et al.* 2018;). However, it is crucial to understand that while the same underlying mechanism can produce distinct phenotypes in the same patient, separate processes can cause similar or nearly identical observable features in asthma patients (Belgrave *et al.* 2013; Custovic *et al.* 2015). In order to accurately pinpoint the underlying causes of asthma and provide a customized treatment plan for each patient, objective measurements like lung function are crucial (Belgrave *et al.* 2017).

The Tahs cohort study hypothesizes the existence of many asthma subtypes, each with unique symptoms, biomarkers, and outcomes. In order to better understand the heterogeneity of asthma, modern statistical approaches like latent class analysis (LCA) should be used. Phenotyping based solely on questionnaire data may no longer be sufficient for appropriately diagnosing asthma. LCA techniques can be used to more fully comprehend the underlying causes of asthma and its numerous subtypes since they have the ability to find innovative and statistically distinct classes among individuals in a relatively impartial manner.

A crucial tool for population management and research, artificial intelligence algorithms can help identify, categorize, and diagnose AA. This technique is a two-step procedure that identifies concepts associated to AA in text using natural language processing and then classifies each record's AA status. This approach can enhance AA treatment in general and collect information for extensive, multi-center population research. With the help of this approach, connections between LCA categories and clinically significant AA outcomes may be shown, facilitating the early detection and diagnosis of AA. The method has been proven effective in a variety of real-world situations (Juhn *et al.* 2020).

2.3.2. Epidemiology

According to the Global Initiative for Asthma (Global Initiative for Asthma 2020), the prevalence of AA ranges from 1% to 18% globally, affecting over 300 million people. The prevalence of AA varies between 2% and 5%, according to the European Respiratory Health Survey Community. Increased susceptibility to atopic diseases such allergic rhinitis and eczema has been associated to the occurrence of AA in both children and adults, which is on the. The rise in prevalence is paralleled by an increase in incidence. Additionally, AA is more prevalent in boys during childhood, whereas it is more prevalent in females in adult populations (Dharmage *et al.* 2019).

2.3.3. The burden of disease

A large fraction of the global population is impacted by AA, with an estimated 1 in 250 people, or roughly 250,000 people, affected globally. However, this figure will rise by an additional 100 million people by the year 2025. The World Health Organization uses Disability adjusted life years (DALYs) to measure the effect of asthma on both society and the individual. The total number of years lost as a result of early mortality and disability brought on by a particular illness or sickness is known as DALYs. According to reports, 15 million DALYs are lost due to asthma globally each year, which represents around 1% of the health losses brought on by all diseases (Global Initiative for Asthma, 2020). These figures demonstrate how common asthma is and underscore the heavy toll it takes on the world's health.

2.3.4. Pathophysiology

Research studies on the pathophysiology of AA are expanding as its prevalence does across the globe. On how the asthmatic process began, there is still disagreement. Studies that link respiratory illnesses to AA also link it to environmental triggers or genetic predisposition. The hygiene hypothesis, which contends that improved environmental hygiene standards reduce allergic reactions by limiting exposure and the risk of infection,

is one widely recognized explanation. This theory proposes that exposure to bacterial or infectious stimuli enhances immune function and guards against atopy. Early childhood infections and allergen exposure may lower the incidence of AA and other allergy illnesses by altering the immune system's Th1-Th2 balance. Healthy people convert some Th2 cytokines to Th1 cytokines to regulate their immune systems. The newborn Th2 cytokine immune system has a profile. Modern times' strict cleanliness regulations and changing living conditions, however, obstruct this process and cause people to develop an atopic structure (Ho 2010).

2.3.5. Bronchoconstriction

After exposure to allergens or irritants, the airways narrow, which reduces airflow and is a characteristic of AA. Histamines, prostaglandins, and leukotrienes generated from mast cells in conjunction with IgE following contact to the allergen/irritant cause bronchoconstriction to occur quickly in the airways during acute exacerbations. Bronchoconstriction can also be brought on by substances like aspirin, exercise, and cold weather in addition to allergens and irritants. Airway edema, inflammation, and mucus hypersecretion as well as airway smooth muscle hypertrophy and hyperplasia all contribute to airway narrowing as the condition worsens (Agrawal and Shao 2010).

Airway hypersensitivity, a syndrome in which the airways react excessively to an excitatory/irritating agent, causes significant bronchoconstriction, makes symptoms in patients with chronic AA more severe. Airway hyperresponsiveness, inflammation, and structural alterations in the airway result in increasing sensitivity and airway narrowing as the severity of AA grows (Agrawal and Shao 2010).

2.3.6. Classification

Based on the cause of the disease and two main subgroups, asthma can be classified.

2.3.6.1. Allergic asthma

The immune system's involvement with immunoglobulin E (IgE) results in AA, a kind of asthma. While it can happen to anyone at any age, research indicate that school-aged children are more likely to experience it than females. In contrast to triggers found outside the home, such as inhaled pollen and irritants, interior allergens such mites, cockroaches, household dust, animal secretions, fungal infections, and food are more common (Wang *et al.* 2022).

2.3.6.2. Non-allergic asthma

There are several non-allergy asthma triggers, and they vary depending on the patient's age. Viral infections are the most common causes of triggering in infants. It has been hypothesized that an early sensitizing mechanism may have a role in the occurrence and severity of asthma in children, especially acute respiratory infections before the age of two. Even in the absence of atopy, this process might repeat, which later worsens allergic asthma symptoms. Beta-blockers, non-steroidal painkillers or anti-inflammatories, exercise, psychological issues, pollution, chemical irritants, tobacco smoke, changes in the weather, psychological issues, mood or hormone changes, or physical causes can all be triggers. Exposure to tobacco smoke during pregnancy and after delivery has been linked to decreased lung capacity and function, and epigenetic changes in DNA methylation patterns may be responsible for the surge in proliferative crises. It is also believed that other variables, like as preterm, low birth weight, and early-mature supplementary feeding, are linked to childhood asthma. In all situations, the immune system is still developing, making it possible for it to react abnormally to some stimuli, leading to hypersensitivity (Chau-Etchepare *et al.* 2019).

2.3.7. Diagnosis of asthma

Wheezing, nighttime coughing, and symptoms brought on by exercise, allergens, viral infections, extreme weather changes, strong emotions, stress, and even the menstrual

cycle are among the symptoms that suggest the possibility of having asthma. After using a bronchodilator, spirometry is preferred in children older than 6 years old to confirm the diagnosis and identify airflow obstruction; an increase in forced expiratory volume in the first second (FEV1) of between 12% and 200 ml is regarded as significant. Along with bronchial stimulation tests to identify hyperirritability, allergy investigations, induced sputum studies, and fiberoptic bronchoscopy for histopathology, if appropriate, a physical examination and objective assessments of airflow blockage are also crucial. To assist in differential diagnosis, further complementary tests may be employed (Lizzo and Cortes 2022).

2.3.8. Signs of asthma

An asthmatic patient's whining sound as heard through a stethoscope. Recurrent episodes of coughing, chest tightness, wheezing, and shortness of breath are symptoms of AA. Sputum may be produced, although it is not always produced, and evacuation is not always ensured. The cough that develops after an assault can resemble pus because it has a high concentration of eosinophilic white blood cells. Typically, symptoms get worse at night and in the morning, particularly after physical activity or exposure to cold air. While symptoms in some AA patients are uncommon and typically appear after exposure to triggers, other individuals may experience symptoms that are severe and chronic (Dünser *et al.* 2018).

2.3.9. Related terms of asthma

Other issues, such as sinusitis, obstructive sleep apnea, and gastroesophageal reflux disease (GERD), are more prevalent in AA patients than in non-asthmatics. The prevalence of psychiatric issues is much higher, with anxiety disorders accounting for 16-52% and mood disorders for 14-41% of asthmatic patients, respectively. Nevertheless, it is unclear if AA contributes to psychological anguish or if psychological distress contributes to AA (Jung *et al.* 2010).

2.3.10. Risk factors of asthma

A complicated and poorly understood network of genetic and environmental interactions underlies the development of AA. These factors affect the severity of the sickness and the way that treatment works. The current increase in AA is thought to be the result of changes in epigenetic variables (genetic factors unrelated to DNA structure) and changes in the living environment (Bohacek and Mansuy 2013).

2.3.10.1. Environmental factors

Allergens, air pollution, and other environmental pollutants are only a few examples of the environmental factors that have been linked to the onset and progression of AA. Smoking has been connected to an increased prevalence of symptoms similar to AA during and after pregnancy. Additionally, a low air quality index brought on by traffic pollution or high ozone levels was associated with the onset and severity of AA. Exposure to indoor Volatile Organic Compounds (VOCs) could be an AA trigger. This has been shown, for instance, when formaldehyde has been inhaled, and AA in both children and adults has also been linked to phthalates. Polyvinyl chloride (PVC) with high dosages of endotoxin exposure (Singh *et al.* 2016).

The most common indoor allergens associated with AA include mites, cockroaches, animal dander, and mold. It has been established that measures to reduce indoor dust mite populations have no impact on AA episodes. Some viral respiratory infections, including rhinovirus and respiratory syncytial virus, can increase a child's risk of developing AA. Contrarily, infection with some other factors may reduce the risk of developing AA (Pomés *et al.* 2016).

2.3.10.2. Obesity

Obesity and the likelihood of developing AA, both of which have increased in frequency recently, are related. Adipose tissue's ability to generate inflammation and its impact on

respiratory function are just two of the potential processes at play. Propranolol is one example of a beta-blocker drug that may make AA worse in vulnerable people. However, the use of cardio-selective beta-blockers seems to be safe in those with mild to moderate disease. Angiotensin-converting enzyme inhibitors, aspirin, and other nonsteroidal anti-inflammatory drugs can also cause discomfort (Forno *et al.* 2017).

2.3.10.3. DNA

A risk factor for AA is a family history of the disease, and numerous unique genes are involved. If one identical twin has AA, the other has a 25% higher chance of developing it. By the end of 2005, 25 AA genes have been linked in six or more unrelated groups, including GSTM1, IL10, CTLA-4, SPINK5, LTC4S, IL4R, and ADAM33. The immune system or the initiation of an inflammatory response are two processes in which many of these genes play a role. Even for this set of genes, whose participation was supported by numerous research, the outcomes varied depending on the group being studied. In a single genetic association study conducted in 2006, more than 100 genes were linked to AA, and more genes were later found to be related (Park *et al.* 2013).

2.3.10.4. Hygiene hypothesis

The Hygiene Hypothesis posits that decreased exposure to non-infectious viruses and germs during childhood is a direct and unintended result of the increased prevalence of AA worldwide. It has been suggested that increased hygiene and fewer family members in contemporary culture are partially responsible for the decreased exposure to germs and viruses. The hygiene theory is supported by the declining prevalence of AA in rural families and households with dogs (Brunekreef *et al.* 2009).

The emergence of AA has been connected to pediatric antibiotic use. An increase in the incidence of AA of 20–80% is linked to cesarean birth. This is due to the fact that the important, benign bacteria that are present during the child's passage through the birth

canal are not present in the newborn's intestines. A connection between AA and money also exists (Singh *et al.* 2016).

2.3.10.5. Health disorders

Asthma development is significantly influenced by atopy, which is characterized as the co-existence of atopic eczema, allergic rhinitis, and AA. Acne and hay fever sufferers are also more likely to acquire asthma. Additionally, AA has been connected to a number of other illnesses, including vasculitis, autoimmune disorders, and Churg-Strauss syndrome. According to Bantz et al. (Bantz *et al.* 2014), some urticaria varieties have also been linked to the emergence of asthma symptoms.

2.3.11. Treatment of AA

Although there is no known cure for AA, a focused and unique treatment strategy can frequently reduce symptoms. Proactive monitoring and symptomatic management should be part of this strategy, along with measures to reduce allergen exposure, assess the severity of symptoms through tests, and take medication as needed. The strategy should be written down and specify therapy modifications based on changes in symptom severity. For immediate symptom relief, short-acting bronchodilators are advised (Forno *et al.* 2017).

A comprehensive treatment program for AA includes drug therapy, pulmonary rehabilitation, psychological support, patient education, smoking cessation, control of the work environment and exposure to allergens, as well as avoidance, and pharmacological and nonpharmacological treatment (Forno *et al.* 2017).

2.3.12. Drug therapy of AA

Since persistent inflammation in the airways is the most important illness feature, the main objectives of AA treatment are to control inflammation and lessen symptoms. An individualized treatment plan should be created to decrease allergen exposure, evaluate symptoms, and take drugs in order to achieve this. The goals of this plan are to lessen daytime symptoms, stop nocturnal awakenings, prevent AA attacks, allow for normal activity levels, improve respiratory function (i.e., FEV1 and PEF values above 80%), and lessen medication side effects (Edmonds *et al.* 2012).

Control drugs and reliever drugs make up the two categories of pharmaceuticals used in the usual drug therapy for AA. To reduce airway inflammation, stop exacerbations, and maintain symptom management, control medications are frequently utilized. These medications include oral and inhaled corticosteroids, long-acting beta-2 agonists, leukotriene receptor antagonists, slow-release theophylline, and long-acting anticholinergics. However, when quick symptom alleviation is required, especially during exacerbations, reliever medications are employed. Regular drug use can reduce inflammation, enhance symptoms, such as better respiratory function, reduce airway hyperactivity, and avoid exacerbations. Even if no symptoms are present, stopping medication can cause a return of asthma-related symptoms (Edmonds *et al.* 2012). As a result, it is crucial that patients take their medications as directed by their treatment plan.

2.3.12.1. Long-term (preventive) treatment

Patients with asthma receive regular anti-inflammatory medication to manage the inflammation and remodeling processes in their airways. Additionally, analgesic medications may be added to the regimen when necessary to control symptoms. However, because AA symptoms and severity vary between patients and over time, treatment should be modified in accordance with each patient's individual disease severity. "Stepwise therapy" is the term used to describe this type of therapeutic strategy (Kostakou *et al.* 2019).

2.4. Adults and children with severe asthma

A small minority of people with a high disease burden may experience severe asthma, which requires substantial doses of inhaled corticosteroids (ICS) and other aids to control. Severe asthma necessitates this kind of treatment, according to the American Thoracic Society (ATS) working committee, a member of the European Respiratory Society (ERS). The extreme end of the spectrum for many different endogenous asthma patterns, however, is probably severe asthma. According to several studies, estimates of the prevalence of severe asthma vary greatly. While Danish surveys report 8% of severe asthmatics, Swedish primary care patients were reported to have the condition at a prevalence of 4.2%. According to certain research, 20–30% of asthmatics may exhibit at least a few symptoms of a severe condition. Compared to adult asthma, childhood asthma seems to have a lower prevalence of severe cases. Note that data from several research (Chung *et al.* 2014; Dharmage *et al.* 2019; Larsson *et al.* 2018; Bousquet *et al.* 2010; Mincheva *et al.* 2018) make it impossible to pinpoint the precise prevalence of severe asthma.

Variable birth cohorts have variable rates of severe AA in children with asthma. For instance, in a Swedish birth cohort, only 7 out of 329 asthmatic children aged 12 had severe AA, translating to a prevalence of 2.1% among asthmatic children and a general population prevalence of 0.23% (Bousquet *et al.* 2010). Similarly, only 3 out of 616 infants in a Norwegian birth cohort had severe AA, translating to an estimated population frequency of 0.5% and 4.5% among children with asthma (Lang *et al.* 2019). These data imply that there may be a greater prevalence of severe AA than previously believed among children with asthma. Current definitions of severe asthma may not include a portion of children with persistently bothersome wheeze who still have considerable symptoms and require medical attention. As a result, when defining severe asthma, other parameters like lung function, FeNO levels, and hyperreactive airways must be taken into account (Bousquet *et al.* 2010). To better understand the causes of severe asthma in children and its repercussions, as well as to develop diagnostic and therapeutic approaches, more study is required.

Although "maximum treatment" is frequently used as a gauge for controlling severe AA, it has drawbacks such inaccurate diagnosis, medication non-adherence, and disease resistance. Thus, in order to precisely characterize severe AA, reliable and comprehensive data on medication use are required to complement the data on "maximum treatment" (Bousquet *et al.* 2010). In 2010, Bush and Saglani developed the term "Problematic Severe Asthma" (PSA) as a useful clinical and research paradigm for examining severe childhood asthma (Bush and Saglani 2010). PSA can be broken down into three distinct categories: severe therapy-resistant asthma (STRA), co-morbid asthma (Asthma plus), and difficult-to-treat asthma (DA), which can occasionally overlap.

Severe asthma episodes in children are caused by a variety of reasons, including poor adherence to medical therapy, exposure to environmental variables such allergens, tobacco smoke, and air pollution, and psychosocial issues (Gehring *et al.* 2013; Molter *et al.* 2015, Saglani *et al.* 2016). By addressing these factors, asthma symptoms can be reduced and asthma control can be improved (Murray et al. 2006, McDonald and Yorke 2017,). To treat their symptoms, however, children with severe food allergies and asthma may need extra interventions (Roberts 2017).

Children with difficult-to-treat asthma (DA) and asthma with multiple characteristics (AA plus) may occasionally not get better despite therapies and treatments meant to target modifiable variables and comorbidities because of poor medication adherence or persistent allergen exposure. In these situations, the children are thought to have refractory DA or refractory AA plus, and in order to properly manage the illness, it's crucial to find and treat any potential underlying causes of the refractory symptoms. Furthermore, it is critical to do research on cutting-edge therapies and tactics to enhance the management and control of DA and AA +. Although PSA, DA, and STRA are helpful for identifying severe asthma in adults, some research contend that children and adults with severe asthma have different symptom patterns. While children's asthma is more changeable and fast evolving, severe attacks that frequently go undiagnosed in between are more common in adults with severe asthma. Therefore, it's imperative to discover problems early and take action to reduce their long-term effects. The distinctions between children and adults with severe asthma, meanwhile, might have been exaggerated. Future

cases of severe adult asthma may be predicted by the pattern of severe disease already seen in pediatric clinics. There have been reports of reduced innate antiviral immunity and decreased interferon induction to rhinovirus in both children and adults with severe asthma (Jackson *et al.* 2010, Edwards *et al.* 2013, Kim *et al.* 2018). Children with early-onset problematic asthma showed different patterns of blood mononuclear cell responses to rhinovirus-16 stimulation than did children with late-onset moderate allergic asthma, according to a recent study (Custovic *et al.* 2018). Asthma hospitalization risk has been reported to rise in both children and adults with asthma due to allergic sensitization, excessive allergen exposure, and viral infection, primarily rhinovirus (Green *et al.* 2002).

According to Holt et al. (Holt *et al.* 2016) and Sylvestre et al. (Sylvestre *et al.* 2016), allergic sensitization is a significant risk factor for severe asthma in children and adolescents. There may be different sensitization subtypes, some of which may be more harmful than others, according to recent research (Simpson *et al.* 2010, Lazic *et al.* 2013, Holt *et al.* 2016). Different cross-sectional and longitudinal patterns of component-specific IgE responses associated with the presence, persistence, and severity of asthma in children have been found using component-resolved diagnostics as opposed to conventional skin and blood tests to whole allergen extracts (Simpson *et al.* 2015, Custovic *et al.* 2015, Howard *et al.* 2018, Fontanella *et al.* 2018). These results may contribute to the creation of asthma management plans that are more successful.

2.4.1. Asthma and exercise capacity

An airway obstruction caused by the chronic respiratory condition asthma limits one's ability to exercise and causes shortness of breath. Up to 90% of asthmatics who exercise while exercising experience bronchoconstriction. This is a common trigger. This can result in a sedentary lifestyle, which further limits one's ability to exercise, can worsen one's quality of life, and can also contribute to anxiety. In comparison to their contemporaries, asthmatics frequently have poor physical fitness. Exercise capacity may be measured accurately in both healthy and ill people, including those with asthma, using cardiopulmonary exercise testing.

According to studies, exercise-induced bronchoconstriction occurs in 40–90% of asthmatics, and up to 80% of chronic asthmatics develop respiratory symptoms while exercising (Park *et al.* 2014; Del Giacco *et al.* 2015) As a result, one may become less physically active and adopt a sedentary lifestyle, which can worsen symptoms and lower quality of life (Park *et al.* 2020). Cardiopulmonary exercise testing is an accurate way to assess an individual's ability to exercise, including their anaerobic threshold and peak exercise capacity. Studies have revealed that it can be used safely in asthmatics despite safety concerns (Albouaini *et al.* 2007).

In conclusion, asthmatics frequently experience exercise-induced bronchoconstriction, which can result in decreased exercise tolerance and a sedentary lifestyle. In comparison to their contemporaries, asthmatics frequently have poor physical fitness. Exercise capacity may be measured accurately in both healthy and ill people, including those with asthma, using cardiopulmonary exercise testing.

2.5. Environmental factors linked to asthma in children and adults

Recent research has demonstrated that a complex interaction of intrinsic factors including genetics and atopy, as well as environmental factors, is the root cause of childhood-onset asthma. Exposure to different airborne triggers, such as animal hair, dander, pollen, mold spores, food allergies, tobacco smoke, and other pollutants, can cause both allergic and non-allergic asthma. Researchers are also looking at the connections between allergens, asthma, and indoor, outdoor, and workplace air pollution. Long-term exposure to particulate matter has been related to a higher incidence of asthma in both children and adults. In addition, indoor air pollutants, such as those brought on by wood burning, might aggravate asthma symptoms. Breastfeeding, food, and obesity are examples of lifestyle factors that can affect asthma onset and progression. In addition to breastfeeding exclusively throughout the first six months of life, a good diet and keeping a healthy weight can reduce the chance of getting asthma. Therefore, it is evident that the onset and progression of asthma are both influenced by a confluence of environmental, genetic, and behavioral variables (Dharmage *et al.* 2019).

Table 2.1 AA risk factors for children and adolescents

ALLERGIC	**SPECIFICS**
Airborne triggers	AA is a typical type of asthma, especially among children at high risk. Regarding the connection between pet allergies and AA, there is conflicting information. However, it has been discovered that grass pollen can cause very bad AA flare-ups that may need immediate medical attention. Indoor fungal spore exposure has been linked to the management of severe AA, with low levels of visible mold lowering symptoms but not PEFM variability. (Salo *et al.* 2006, Burr *et al.* 2007, Lodge *et al.* 2011, Lodrup-Carlsen *et al.* 2012, Erbas *et al.* 2018).
Food allergens	Even though food allergies are a less frequent cause of AA, they have the potential to produce serious and even fatal episodes, especially in people who are allergic to peanuts or other tree nuts. Cow's milk, peanuts, tree nuts, shellfish, and egg white are typical food allergens that can cause AA. (Liu *et al.* 2010, Burks *et al.* 2012).
Sensitizing high molecular weight	High molecular weight sensitizers are chemicals that can make people allergic to certain things. Animal allergens that affect people who work with animals in labs or as handlers can also include plant allergens such as latex, wheat, and flowers. Furthermore, fungi-yeasts and biological enzymes can act as high molecular weight sensitizers. The health effects of these agents on humans have been studied by (Baur *et al.* 2014) and (Crewe *et al.* 2016).
Sensitizing low molecular weight	Asthma, allergic rhinitis, and skin sensitization are just a few of the negative effects that low molecular weight substances can cause in people. Isocyanates, reactive dyes, industrial cleaning and sterilizing chemicals, metals, medicines, solder flux, and wood dusts are a few examples of these substances. It is crucial to wear protective gear and use caution when dealing with these chemicals because exposure to them has been associated with a higher risk of sensitization and other health issues. (Crewe *et al.* 2016).

Table 2.1 (continued) AA risk factors for children and adolescents (continued)

NON-ALLERGIC	SPECIFICS
Respiratory viral infections	It is well recognized that factors such as cold air, humidity, and exercise-induced respiratory virus infections can aggravate asthma symptoms and obstruct airways. The chance of having asthma is raised by several environmental factors (Global Initiative for Asthma, 2020). Preventive strategies, such as minimizing exposure to cold air, high humidity levels, and exercise-induced respiratory virus infections, are crucial to reducing the chance of getting asthma. Patients with asthma should think about taking medication to control their symptoms and lower the chance of exacerbations (Global Initiative for Asthma 2020).
Exposure to tobacco smoke	A well-known risk factor for childhood asthma and wheeze is parental smoking. Children who do not have allergies or who were exposed to maternal smoking in utero are more likely to develop asthma after being exposed to secondhand smoke. According to studies (Genuneit *et al.* 2006, Gilliland *et al.* 2006, Burke *et al.* 2012), regular smoking throughout late childhood and beyond may further raise the likelihood of getting asthma. Personal smoking, on the other hand, can increase symptoms and decrease asthma control (McLeish *et al.* 2010). Asthma and chronic obstructive pulmonary disease (COPD) coincide with personal smoking, which can also reduce airflow after bronchodilator administration (Perret *et al.* 2016). To prevent and manage asthma in both children and adults, it is imperative to refrain from smoking and from being around secondhand smoke.
Household air pollution (HAP)	It has been demonstrated that using non-polluting home heating systems has a good impact on asthma symptoms, absenteeism from school, and healthcare use in asthmatic children (Howden-Chapman *et al.* 2008). Asthma sufferers gain from this, and the strain on healthcare systems is lessened. Additionally, enhanced house heating can help everyone live in a more pleasant and healthy atmosphere.

2.6. Health effects of asthma in children and adolescents

Due to its impact on the immune system, asthma can result in lower levels of immunoglobulins and higher levels of neutrophils and eosinophils, which can raise the risk of mycobacterial and fungal infections (Zaidi and Blakey 2019). Additionally, asthma has been linked to other long-term conditions including cystic fibrosis as well as detrimental psychological outcomes like anxiety and despair. Although the precise origin of asthma-related chronic airway inflammation is uncertain, it is believed that immunomodulating medications, such as inhaled corticosteroids, and airway mucosa damage may contribute to the condition. Some people with asthma have also shown lower

antibody levels in response to the pneumococcal vaccine, suggesting that their immune systems may not react to the vaccine effectively (Zaidi and Blakey 2019). According to studies by Talbot et al. (Talbot *et al.* 2005) and Helby et al. (Helby *et al.* 2017), people with asthma who have never smoked had a higher chance of contracting invasive pneumococcal illness as well as other respiratory and non-respiratory infections. The precise advantages of vaccination for persons who have asthma require further study (Klemets et al. 2010, Juhn 2014).

Diabetes, osteoporosis, metabolic syndrome, cardiovascular illnesses, anxiety, and depression are only a few of the chronic conditions and mental health problems that adult asthma has been associated to (Kankaanranta *et al.* 2016). According to a recent study (Kankaanranta *et al.* 2016), adult eczema and food allergies are also linked to asthma in adults. Nearly two thirds of asthma patients have at least one comorbid condition, and 16% have four or more (Weatherburn *et al.* 2017). Comorbid conditions can significantly affect an asthma patient's quality of life. These comorbidities are probably linked to asthma and can be brought on by a number of things, including asthma itself, other comorbid illnesses, shared environmental risk factors, shared genetic risk factors, or a combination of these things. To guarantee better results for individuals and healthcare systems, comorbidities must be taken into account when diagnosing and treating asthma (Gershon *et al.* 2012).

2.6.1. Relationship between AA and level of physical activity

Physical activity has been demonstrated to have a variety of health advantages, including favorable effects on psychological function, quality of life, and cardiorespiratory fitness (Warburton *et al.* 2018). Physical activity is defined as movements that increase the body's skeletal muscle contraction and energy expenditure. Asthma symptoms, however, have been shown in studies to reduce daily physical activity in asthmatic patients compared to healthy individuals. Pedometer applications and feedback have been shown to boost these patients' levels of physical activity. According to the literature, exercise-induced bronchoconstriction, a lack of information about the advantages of physical

activity, and a lack of desire are the main causes of decreased physical activity among asthmatics (Park *et al.* 2022).

2.7. Relationship between lifestyle changes and AA

Avoiding factors that aggravate symptoms is essential for managing asthma and preventing episodes. Allergens, smoke from various sources, air pollution, non-selective beta-blockers, and foods containing sulfites are a few common causes. Smoking and exposure to secondhand smoke are among these triggers that have been demonstrated to reduce the effectiveness of corticosteroid drugs used to treat asthma (Win and Hussain 2008).

2.8. Relationship between aa and quality of life

The patient's verbal expression is referred to as disease-specific quality of life (QOL), which is one of the key outcome measures reflecting the effect of treatment on the patient. An individual's QOL has been demonstrated to be considerably impacted by asthma. This effect is caused by psychological and social variables, and as asthmatics frequently experience heightened stress, this can further impair their quality of life. According to objective measurements, increased self-respiration and shortness of breath are linked to both asthma symptoms and psychological stress (Kharaba *et al.* 2022).

3. MATERIAL METHODS

3.1. Research design

A descriptive study design will be adopted to conduct this research.

3.2. Place and time of research

The research will be conducted in health centers in the city of Mosul from May to July 2022.

3.3. Study preparation

Four health centers in Mosul—Al-Sfina Health Center, Umm Al-Manasis Health Center, Al-Houd Health Center, and Ashwirat Health Center—identified a total of 1180 children and adolescents with asthma. Figure 3.1 illustrates the results of the G. Power Analysis used to calculate the sample size from this group, which was 290 patients.

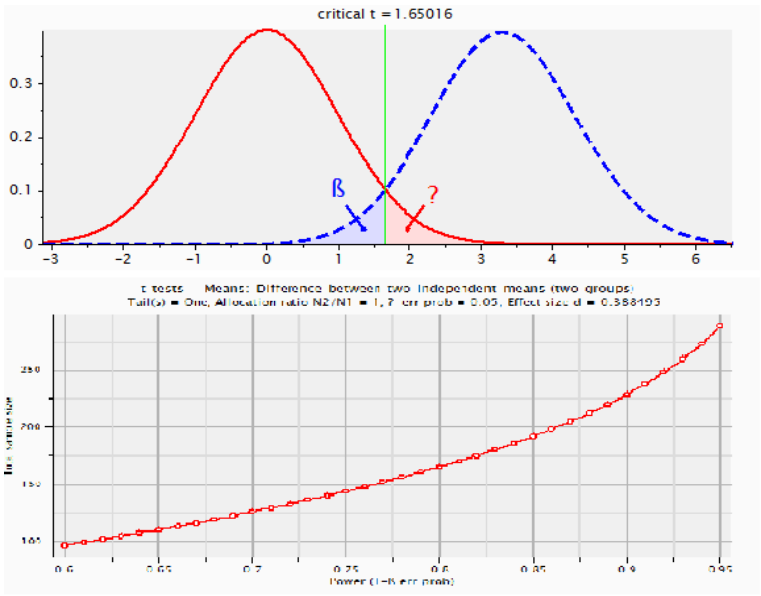

Figure 3.1 G-Power Analysis

3.4. Study sample

3.4.1. Sampling criteria

Children and adolescents with asthma who receive medical care at particular Mosul-area health centers meet the sampling requirements for this study. Participants must freely agree to take part in the study and must be between the ages of 6 and 17. The inclusion criteria were created to uphold ethical considerations in research involving human subjects and to guarantee that the sample appropriately represents the target community.

3.4.2. Exclusion criteria

A prior diagnosis of a mental condition and a refusal to engage in the study are exclusion factors for this investigation. These requirements were set up to make sure that the study participants were willing to give their informed permission and did not have any pre-existing conditions that could have a negative impact on the accuracy of the results.

3.5. Data collection tools

3.5.1. Socioeconomic characteristics of patients

Face-to-face interviews with a questionnaire were used to gather information on the socioeconomic traits of the patients. The data collecting process took an average of 20 to 25 minutes. The patients' socioeconomic details were gathered using a personal information form (Appendix 1). The four questions on age, gender, educational attainment, and smoking status were all part of the personal information form.

3.5.2. International study of asthma and allergies in childhood scale

The International Study of Asthma and Allergies in Childhood (ISAAC) by Asher et al. (Asher et al. 2008) was used in multiple studies for validation and reliability, including those conducted by Al Ghobain et al. (Al Ghobain *et al.* 2012), Alahmadi et al. (Alahmadi *et al.* 2023), and Hallit et al. (Hallit *et al.* 2016) who conducted a validation and reliability study in Arabic. The questionnaire was administered to children and adolescents between the ages of 8 and 18, who were able to understand the questions with or without the help of their parents or an interviewer. The questionnaire covered various factors related to prevalence, indoor and outdoor allergens, air pollution, significant risk factors for wheezing and asthma, and atopic diseases in children/adolescents. It also included questions about home environment, exposure to secondhand smoke, viral respiratory infections, fast food consumption, and associated chronic diseases. ISAAC consists of 5 sub-dimensions, with the highest value observed at 74 and the lowest value at 31. The first sub-dimension includes 7 questions related to nasal problems, with response options ranging from yes = 2 to no = 1 for 6 questions, and a question with response options of not at all = 1, little = 2, moderate amount = 3, and a lot = 4. The highest value for this sub-dimension is 16 and the lowest value is 7. The second sub-dimension focuses on skin problems, with 5 questions and response options of yes = 2 to no = 1 for most questions, and response options of Never in the past 12 months = 1 and One or more nights per week = 3 for one question. The highest value for this sub-dimension is 13 and the lowest value is 6. The questions in this sub-dimension relate to having an itchy rash in various body areas, sleep disturbances due to skin rashes, and eczema. The third sub-dimension assesses the prevalence and severity of asthma, with 6 questions and response options of yes = 2 and no = 1. The highest value for this sub-dimension is 12 and the lowest value is 6. The fourth sub-dimension focuses on the prevalence of specific asthma symptoms, with 6 questions and response options ranging from Never / Never woken up / No = 1 to Continuously = 4, and one or more nights per week = 3, and yes = 2. The highest value for this sub-dimension is 17 and the lowest value is 6. The fifth sub-dimension assesses factors related to current noise exposure, with 6 questions and response options of yes =

2 to no = 1, Never or only occasionally = 1, and Most or all days = 3. The highest value for this sub-dimension is 16 and the lowest value is 6 (Appendix 1).

3.6. Search variables

3.6.1. The dependent variable

Age, gender and educational status, smoking and presence of chronic disease.

3.6.2. Independent variables

Risk factor of AA.

3.7. Data analysis

The collected data will be evaluated in the SPSS software with a threshold of significance set at $P<0.05$ utilizing a variety of statistical techniques, including frequency, percentage, mean, standard deviation, one-way analysis of variance (ANOVA), and independent samples t-test. The software program SPSS is frequently used for statistical data analysis and provides a variety of features and analysis methods for various data types. The independent samples t-test is used to assess if there are statistically significant differences between the means of two groups, whereas ANOVA is a statistical tool that separates the total observed variance of a data set into systematic and random variables. When many hypotheses are tested, the Bonferroni correction will also be employed to modify the significance level and lower the possibility of Type I errors.

3.8. Ethical dimension of research

On May 25, 2022, the study received ethical approval from Iraq. To do so, a thorough explanation of the study's goals and methods was given (Appendix 2). The process was made easier by the Nineveh Health Directorate's approval of the study idea. Participants

were verbally told of the study's goals and requested to participate voluntarily before being admitted to the hospital. To protect the privacy of the participants, the confidentiality of their information was ensured, and no names were recorded during data collecting and reporting. The ability to refuse to answer a specific question or to withdraw from the study at any time without incurring any consequences was also made clear to participants. Additionally, the scale was used with the author's consent (Appendix 3).

4. RESULTS

Using a straightforward random sample technique, the study sought to determine the frequency of AA among children and teens seeking medical attention in Mosul, Iraq, health clinics. As illustrated in Figure 4.1, four health facilities—Al Safina Health Center, Umm Al Munaiss Health Center, Al Houd Health Center, and Al Ashawirat Health Center—were chosen as the study sites. To better understand the prevalence of AA among children and adolescents seeking medical attention in the city of Mosul, the study additionally examined the association between demographic information and the incidence of AA.

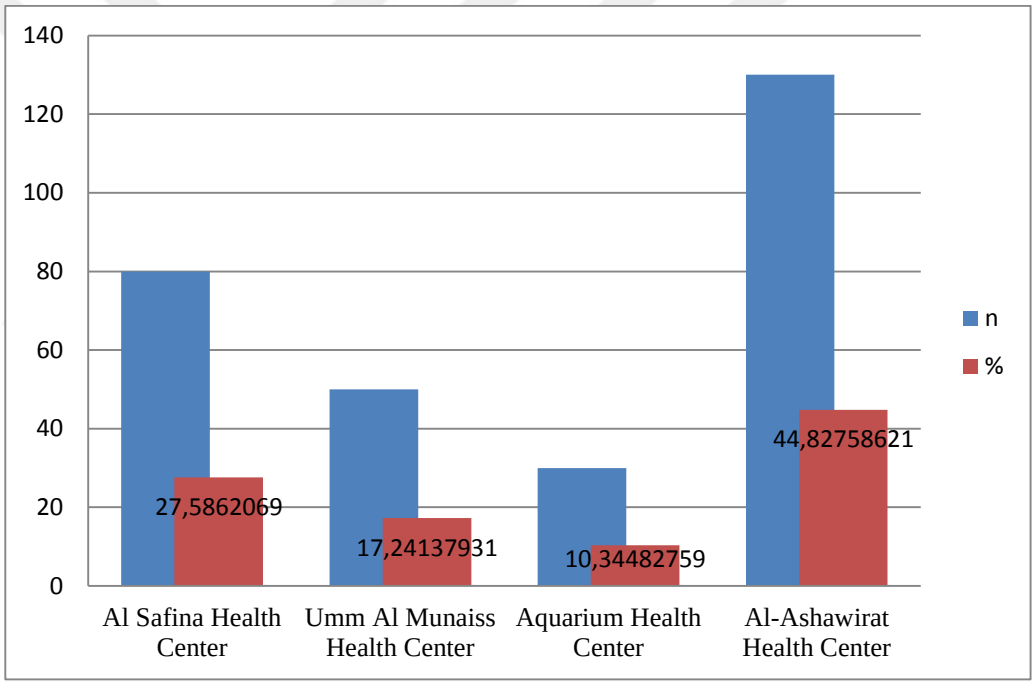

Figure 4.1 Relative distribution of the study population by health center

Al-Ashawirat Health Center (44.82%) represents the majority of the study sample, with the remaining samples being allocated among the other health centers Al Safina Health Center (27.58%), Umm Al Munaiss Health Center (17.24%), and Aquarium Health Center (10.34%).

Table 4.1 Study sample distribution related socioeconomic characteristics for adolescents in health centers in Mosul, Iraq prevalence o Asthma

		Frequency	Percent
Age	6-10	238	82.1
	11-14	40	13.8
	15-17	12	4.1
	Total	290	100.0
Mean ± standard divaition : 13.91±2.78 years			
Gender	Female	87	30.0
	Male	203	70.0
	Total	290	100.0
Economic level	Not Enough	136	46.9
	Enough	154	53.1
	Total	290	100.0
Family size	≤ 3	71	24.5
	4-5	121	41.7
	6<	98	33.8
	Total	290	100.0
Presence of chronic disease	No	208	71.7
	Yes	82	28.3
	Total	290	100.0
Smoking	No	218	75.2
	Yes	72	24.8
	Total	290	100.0

Abbreviations: %: percentage, SD: Standard deviation,

The study's findings are presented in Table 4.1, which also includes a summary of the participants' main demographic details. The individuals' average ages were 13.91, with a 2.78 standard deviation. The majority of the study's participants, approximately 70% of them, were men, with the remaining 20% being women. A suitable level of income was also indicated by 53.1% of the sample as a whole. According to the analysis of family size, the biggest proportion (40.9%) had a family size of between 4-5 individuals, followed by 33.1% with a family size of 6 or more, and the smallest percentage (24.5%) had a family size of less than 3. The majority of the sample (75.2%) did not smoke, whereas the remaining respondents admitted to smoking. In addition, a sizable portion of

survey participants (71.7%) reported not having any chronic conditions, whereas the remainder admitted to having them.

Table 4.2 Study sample distribution for dimension prevalence of related asthma and related factors among adolescents in health centers in Mosul, Iraq

		Frequency	**Percent**	**ISAAC Mean±SD**
Nose problems (7-16)	Yes	290	100.0	10.02±1.35
>7=Yes				
Skin problems (6-13)	No	50	17.2	8.10±1.42
	Yes	240	82.8	
	Total	290	100.0	
>6=Yes				
Prevalence and severity of AA symptoms (6-12)	No	227	78.3	7.13±2.24
	Yes	63	21.7	
	Total	290	100.0	
>6=Yes				
Specific AA symptoms (8-17)	No	86	29.7	10.83±3.14
	Yes	204	70.3	
	Total	290	100.0	
>8=Yes				
Factors associated with current wheeze (8-16)	no	106	36.6	9.91±2.27
	yes	184	63.4	
	Total	290	100.0	
>8=Yes				

According to the study's findings, practically all children and adolescents have nasal issues. 240 adolescents (82.8%) reported having skin issues, which is a significant proportion of the whole population. However, only 78.3% of children and adolescents reported having severe symptoms, indicating that the severity of the asthma problem was rather mild. The majority (70.3%) of those who reported asthma symptoms had particular symptoms. Furthermore, a sizeable percentage of adolescents (63.4%) listed wheezing as a symptom (Table 4.2.).

Table 4.3 Comparison of Demographic Data and Prevalence of Specific Asthma and Allergies Symptoms in Children and Adolescents in Health Centers in Mosul, Iraq, using the International Study of Asthma and Allergies in Childhood (ISAAC) Sub-dimension (nose problems)

	Valid	N	Dimension Mean	S.D	F	P0	P1	P2	P3
Age	6-10	238	9.75	1.03	45.074	<0.001	<0.001	1.000	<0.001
	11-14	40	11.60	1.95					
	15-17	12	10.00	0.00					
	Total	290	10.02	1.35					
Gender	Female	87	10.21	1.40	2.481	0.116 [x]			
	Male	203	9.94	1.32					
	Total	290	10.02	1.35					
Economic	Not Enough	136	10.86	1.53	149.124	<0.001 [x]			
	Enough	154	9.28	0.45					
	Total	290	10.02	1.35					
Fimaly size	≤ 3	71	9.97	1.37	1.136	0.322	1.000	1.000	0.441
	4-5	121	10.16	1.46					
	6<	98	9.89	1.17					
	Total	290	10.02	1.35					
Presence	No	208	9.96	1.33	1.755	0.186 [x]			
	Yes	82	10.19	1.40					
	Total	290	10.02	1.35					
Smoker	No	218	10.36	1.40	67.953	<0.001 [x]			
	Yes	72	9.00	0.00					
	Total	290	10.02	1.35					

ISAAC: international study of asthma and allergies in childhood
Abbreviations: F: distribution, p-value*: probably, significant at 0.05,* N: Number, SD: standard deviation, [b]One way ANOVA, [x] independent samples t test
P0: p-value
p1: posthoc test (Bonferroni correction) for pairwise comparison of the first and second groups,
p2: posthoc test (Bonferroni correction) for pairwise comparison of the first and third groups,
p3: posthoc test (Bonferroni correction) for pairwise comparison of the second and third groups.

According to the findings, children between the ages of 11 and 14 had more nasal problems than those between 6 and 10 and 15 to 17 years old (p 0.001). Nasal problems were not significantly influenced by gender (p=0.116). In terms of nasal problems there was a significant difference between individuals with sufficient and insufficient income levels (p<0.001). Both prior illnesses and family size did not significantly affect nasal

problems (p=0.322). Smokers, however, scored much higher on nasal problems than non-smokers (p<0.001) did.

Table 4.4 Comparison of Demographic Data and Prevalence of Specific Asthma and Allergies Symptoms in Children and Adolescents in Health Centers in Mosul, Iraq, using the International Study of Asthma and Allergies in Childhood (ISAAC) Sub-dimension (skin problems)

	Valid	N	dimension Mean	S.D	F	P0	P1	P2	P3
Age	6-10	238	8.24	1.34	36.964	<0.001	1.000	<0.001	<0.001
	11-14	40	8.17	0.95					
	15-17	12	5.00	0.00					
	Total	290	8.10	1.42					
Gender	Female	87	7.89	1.50	2.541	0.112 [x]			
	Male	203	8.18	1.38					
	Total	290	8.10	1.42					
Economic status	Not Enough	136	7.08	1.54	237.822	**<0.001** [x]			
	Enough	154	9.00	0.00					
	Total	290	8.10	1.42					
Fimaly size	≤ 3	71	8.35	1.20	2.545	0.080			
	4-5	121	7.89	1.56					
	6<	98	8.17	1.36					
	Total	290	8.10	1.42					
Presence of chronic disease	No	208	8.00	1.50	2.973	0.086 [x]			
	Yes	82	8.32	1.18					
	Total	290	8.10	1.42					
Smoker	No	218	7.80	1.53	43.766	**<0.001** [x]			
	Yes	72	9.00	0.00					
	Total	290	8.10	1.42					

ISAAC: international study of asthma and allergies in childhood

Abbreviations: F: distribution, p-value*: probably, significant at 0.05,* N: Number, SD: standard deviation, [b]One way ANOVA, [x] independent samples t test
P0: p-value
p1: posthoc test (Bonferroni correction) for pairwise comparison of the first and second groups,
p2: posthoc test (Bonferroni correction) for pairwise comparison of the first and third groups,
p3: posthoc test (Bonferroni correction) for pairwise comparison of the second and third groups.

The findings showed that adolescents with asthma of various ages had various degrees of skin issues. Compared to those aged 15–17, children aged 6–10 and 11–15 had higher skin issues (p<0.001). Male and female teenage asthmatics did not significantly differ in terms of skin issues (p=0.112). Children and adolescents with asthma who came from various socioeconomic backgrounds also had diverse degrees of skin issues. Children and adolescents with adequate financial standing had greater skin issues than those with inadequate financial standing (p<0.001). Adolescents with asthma of varied family sizes did not significantly differ in their skin issues (p=0.080). In adolescents with asthma, skin issues were not significantly impacted by prior illnesses (p=0.086). Smoking, however, made a highly significant difference in skin issues. Smokers among adolescents with asthma experienced higher skin issues than non-smokers (p<0.001).

Table 4.5 Comparison of Demographic Data and Prevalence of Specific Asthma and Allergies Symptoms in Children and Adolescents in Health Centers in Mosul, Iraq, using the International Study of Asthma and Allergies in Childhood (ISAAC) Sub-dimension (prevalence and severity of AA symptoms)

	Valid	N	Dimension Mean	S.D	F	P0	P1	P2	P3
Age	6-10	238	6.78	1.94	34.552	<0.001	<0.001	0.571	<0.001
	11-14	40	9.57	2.68					
	15-17	12	6.00	0.00					
	Total	290	7.13	2.24					
Gender	Female	87	7.51	2.42	3.580	0.059 [x]			
	Male	203	6.97	2.15					
	Total	290	7.13	2.24					
Economic status	Not Enough	136	8.42	2.76	118.750	<0.001 [x]			
	Enough	154	6.00	0.00					
	Total	290	7.13	2.24					
Fimaly size	≤ 3	71	7.02	2.09	1.555	0.213	0.785	1.000	0.271
	4-5	121	7.40	2.42					
	6<	98	6.88	2.10					

	Total	290	7.13	2.24					
Presence of chronic	No	208	7.00	2.08	2.415	0.121 [x]			
	Yes	82	7.46	2.59					
	Total	290	7.13	2.24					

Table 4.5 (continued) Comparison of Demographic Data and Prevalence of Specific Asthma and Allergies Symptoms in Children and Adolescents in Health Centers in Mosul, Iraq, using the International Study of Asthma and Allergies in Childhood (ISAAC) Sub-dimension (prevalence and severity of AA symptoms)

Smoker	No	218	7.51	2.47	26.807	<0.001 [x]			
	Yes	72	6.00	0.00					
	Total	290	7.13	2.24					

ISAAC: international study of asthma and allergies in childhood
Abbreviations: F: distribution, p-value*: probably, significant at 0.05,* N: Number, SD: standard deviation, [b]One way ANOVA, [x] independent samples t test
P0: p-value
p1: posthoc test (Bonferroni correction) for pairwise comparison of the first and second groups,
p2: posthoc test (Bonferroni correction) for pairwise comparison of the first and third groups,
p3: posthoc test (Bonferroni correction) for pairwise comparison of the second and third groups.

According to the study results, children aged 11-14 years showed more severe symptoms of asthma than those aged 6-10 ($p<0.001$) and 15-17 years ($p<0.001$). There was no significant difference in the prevalence and severity of asthma and allergies symptoms between male and female adolescents with asthma ($p=0.059$). Adolescents with different economic statuses experienced varying levels of prevalence and severity of asthma and allergies symptoms, with those from higher economic status showing more prevalence and severity ($p<0.001$). Family size did not significantly affect the prevalence and severity of asthma and allergies symptoms among adolescents and children with asthma ($p=0.213$). Previous diseases did not have a significant impact on the prevalence and severity of asthma and allergies symptoms in adolescents with asthma ($p=0.121$). However, smoking had a significant effect, with adolescents with asthma who smoked showing a higher prevalence and severity of asthma and allergies symptoms than non-smokers ($p<0.001$).

Table 4.6 Comparison of Demographic Data and Prevalence of Specific Asthma and Allergies Symptoms in Children and Adolescents in Health Centers in Mosul, Iraq, using the International Study of Asthma and Allergies in Childhood (ISAAC) Sub-dimension (specific AA symptoms)

	Valid	N	Dimension Mean	S. D	F	P0	P1	P2	P3
Age	6-10	238	11.20	3.02	15.581	<0.001	0.046	<0.001	0.002
	11-14	40	9.95	3.19					
	15-17	12	6.58	0.90					
	Total	290	10.83	3.14					
Gender	Female	87	10.86	3.26	0.007	0.932 [x]			
	Male	203	10.82	3.10					
	Total	290	10.83	3.14					
Economic status	Not Enough	136	8.27	2.79	407.471	<0.001 [x]			
	Enough	154	13.09	0.91					
	Total	290	10.83	3.14					
Family size	≤ 3	71	11.59	2.48	3.838	0.023	0.019	0.540	0.424
	4-5	121	10.31	3.31					
	6<	98	10.93	3.27					
	Total	290	10.83	3.14					
Presence of chronic disease	No	208	10.87	3.16	0.130	0.719 [x]			
	Yes	82	10.73	3.11					
	Total	290	10.83	3.14					
Smoker	No	218	10.14	3.32	49.467	<0.001 [x]			
	Yes	72	12.93	0.75					
	Total	290	10.83	3.14					

ISAAC: international study of asthma and allergies in childhood
Abbreviations: F: distribution, p-value*: probably, significant at 0.05, high significant at 0.01,* N: Number, SD: standard deviation, [b]One way ANOVA, [x] independed test
P0: p-value
p1: posthoc test (Bonferroni correction) for pairwise comparison of the first and second groups,
p2: posthoc test (Bonferroni correction) for pairwise comparison of the first and third groups,
p3: posthoc test (Bonferroni correction) for pairwise comparison of the second and third groups.

According to the study's findings, children between the ages of 6 and 10 showed more severe particular asthma and allergy symptoms than children between the ages of 15 and 17 (p=0.001) and 11 to 14 (p=0.046). Additionally, compared to those aged 15–17 years, children aged 11–14 years displayed more severe specific asthma and allergy symptoms (p=0.002). Male and female adolescents with asthma did not significantly differ in their

specific asthma and allergy symptoms (p=0.932). The prevalence and severity of certain asthma and allergy symptoms varied across adolescents from diverse socioeconomic backgrounds, with higher socioeconomic status being associated with both a higher prevalence and severity (p<0.001). Families with three or less members were more likely than families with four or more to experience particular asthma and allergy symptoms (p=0.019). Specific asthma and allergy symptoms in children and adolescents with asthma were not substantially impacted by prior illnesses (p=0.719). Smoking, however, had a substantial impact; adolescents with asthma who smoked showed higher prevalence and severity of asthma and allergy symptoms than non-smokers (p<0.001).

Table 4.7 Comparison of Demographic Data and Prevalence of Specific Asthma and Allergies Symptoms in Children and Adolescents in Health Centers in Mosul, Iraq, using the International Study of Asthma and Allergies in Childhood (ISAAC) Sub-dimension (factors associated with current wheeze)

	Valid	N	Skin problems Mean	S. D	F	P0	P1	P2	P3
Age	6-10	238	10.23	2.19	15.232	<0.001	<0.001	0.002	1.000
	11-14	40	8.55	2.29					
	15-17	12	8.00	0.00					
	Total	290	9.91	2.27					
Gender	female	87	9.57	2.10	2.732	0.099 [x]			
	Male	203	10.05	2.32					
	Total	290	9.91	2.27					
Economic status	Not Enough	136	9.02	2.62	44.340	<0.001 [x]			
	Enough	154	10.68	1.53					
	Total	290	9.91	2.27					
Fimaly size	≤ 3	71	10.02	2.24	0.147	0.863			
	4-5	121	9.90	2.34					
	6<	98	9.83	2.21					
	Total	290	9.91	2.27					
Presence of chronic	No	208	10.00	2.31	1.148	0.285[x]			
	Yes	82	9.68	2.14					
	Total	290	9.91	2.27					

Table 4.7 (continued) Comparison of Demographic Data and Prevalence of Specific Asthma and Allergies Symptoms in Children and Adolescents in Health Centers in Mosul, Iraq, using the International Study of Asthma and Allergies in Childhood (ISAAC) Sub-dimension (factors associated with current wheeze)

Smoker	No	218	8.93	1.62	374.236	<0.001 [x]			
	Yes	72	12.87	1.04					
	Total	290	9.91	2.27					

ISAAC: international study of asthma and allergies in childhood
Abbreviations: F: distribution, p-value*: probably, significant at 0.05, high significant at 0.01,* N: Number, SD: standard deviation, [b]One way ANOVA, [x] independe test
P0: p-value
p1: posthoc test (Bonferroni correction) for pairwise comparison of the first and second groups,
p2: posthoc test (Bonferroni correction) for pairwise comparison of the first and third groups,
p3: posthoc test (Bonferroni correction) for pairwise comparison of the second and third groups.

According to the study results, children aged 6-10 years showed more severe factors associated with current wheeze than those aged 11-14 years ($p<0.001$) and 15-17 years ($p=0.002$). There was no significant difference in the factors associated with current wheeze between male and female adolescents with asthma ($p=0.099$). Children and adolescents from different economic backgrounds experienced varying levels of the factors associated with current wheeze, with those from higher economic status showing a higher prevalence and severity ($p<0.001$). Family size did not significantly affect the factors associated with current wheeze among adolescents and children with asthma ($p=0.863$). Previous diseases did not significantly impact the factors associated with current wheeze in children and adolescents with asthma ($p=0.285$). However, smoking had a significant effect, with adolescents with asthma who smoked showing a higher prevalence and severity of the factors associated with current wheeze than non-smokers ($p<0.001$).

5. DISCUSSION

The findings of this study shed light on the frequency of AA among adolescents and children seeking medical attention in Mosul, Iraq, health centers. A considerable fraction of Mosul's juvenile population is affected by AA, as evidenced by the study's finding that the majority of participants were male and had a mean age of 13.91 years. The results of the study also revealed that the Al-Ashawirat Health Center had the most proportion of participants, followed by Al Safina Health Center, Umm Al Munaiss Health Center, and Aquarium Health Center. This shows that AA prevalence may vary between Mosul's various health facilities, maybe as a result of various environmental and societal causes. The study also examined the connection between demographic information and the prevalence of AA, and it found no significant relationship between family income and prevalence, suggesting that AA affects people from all socioeconomic backgrounds equally. The majority of the interviewees did, however, report having an adequate level of income, which may not accurately reflect Mosul's overall population's financial situation. According to the study's findings on family size, the majority of participants had families with between 4-5 individuals. Larger families may be more exposed to environmental allergens and pollutants, which are known risk factors for AA, even if family size did not significantly affect the incidence of AA. Smokers had a greater incidence of AA than non-smokers, which was another substantial influence smoking had on the prevalence of AA. This research emphasizes how crucial it is to work with families to help young people stop smoking in order to lower the prevalence of AA. Finally, the fact that the majority of participants did not disclose any chronic illnesses suggests that AA is a common health problem among children and adolescents in Mosul who are generally healthy and seeking medical attention. The findings of this study can assist medical professionals and policymakers in creating plans to manage and prevent AA in children and adolescents in Mosul, Iraq.

The findings of this study offer significant new information about the frequency and severity of asthma symptoms in the study population's children and adolescents. The fact that practically every child and adolescent had nose issues is in line with earlier studies showing that allergic rhinitis is a typical comorbidity in people with asthma. According

to research, people with asthma frequently develop atopic dermatitis, which can aggravate asthma symptoms. The high incidence of skin issues reported by study participants is consistent with this finding. The severity of asthma symptoms was rather modest, with the majority of subjects reporting no severe symptoms, despite the high prevalence of nose and skin issues. This is positive because severe asthma symptoms can negatively affect a person's quality of life and raise their chance of developing complications from the condition. The fact that a sizable percentage of participants continued to report having specific asthma symptoms, including wheezing, should be noted since it shows that asthma is still a serious health issue in the research population. The results of this study further emphasize how crucial it is to recognize and manage asthma risk factors that can be changed. For instance, just a small percentage of participants reported smoking, yet it was linked to a higher prevalence of asthma symptoms. This emphasizes the importance of campaigns to prevent and stop smoking in order to lessen the prevalence of asthma in this community. Overall, the study offers important data on the incidence and severity of asthma symptoms in the study population's children and adolescents. To create efficient interventions to lessen the burden of asthma in this population, additional study is required to better understand the underlying causes of these symptoms.

The results of this study offer important new information about the prevalence and risk factors for nasal issues in children and adolescents with asthma seeking medical care in Mosul, Iraq. The findings of the current study are similar with earlier research that shown a significant prevalence of nasal issues in people with asthma (Meltzer *et al.* 2009; Bousquet *et al.* 2008). According to the findings, children between the ages of 11 and 14 were more likely to experience nasal issues than children between the ages of 6 and 10 and 15 to 17. This result is consistent with other research that found that nasal symptoms were more common in this age group, presumably as a result of hormonal changes associated with puberty (Settipane *et al.* 1994; Poddighe *et al.* 2016). The severity of nasal issues was not evaluated in this study, which is significant because further research could examine this. The study also discovered that nasal issues were significantly influenced by household income, with people from higher income households having more severe symptoms. This result is in line with other research (Ginde *et al.* 2008; Shi *et al.* 2015), which found that those from higher socioeconomic backgrounds had a higher

prevalence of nose issues. Although the causes of this correlation are unclear, it may be linked to environmental elements including exposure to allergens and pollutants. Smoking has been found to be a key contributing factor to nasal issues in asthmatic children and adolescents. Asthma smokers have been found to more frequently have nasal symptoms in previous studies (Vasileiadou *et al.* 2021, Jarvis *et al.* 2018). Smoking can irritate the nasal passages and aggravate airway inflammation, which can result in nasal congestion and other symptoms. Therefore, to lower the incidence of nasal issues, healthcare practitioners should emphasize the significance of smoking cessation in patients with asthma. According to earlier studies (Hsu *et al.* 2013, Stenner *et al.* 2014), there are no appreciable changes in nasal issues based on family size and prior illnesses. It is crucial to remember that this study did not look at specific disorders or their severity; rather, it just evaluated whether chronic diseases existed or not. Overall, the results of this study emphasize the significance of taking into account a variety of demographic and lifestyle characteristics when evaluating nasal issues in asthmatic children and adolescents. In order to lower the risk of difficulties, healthcare practitioners should be aware of the potential effects of income level and smoking on nasal symptoms and should offer the proper education and interventions. To better understand the severity and effects of nasal issues in this population, more research is required.

According to the study's findings, the severity of skin issues among children and adolescents with asthma varies with their age and socioeconomic position. Comparing adolescents aged 6-10 and 11-15, those aged 15–17 reported having less skin issues. According to earlier research, younger children with asthma have a higher prevalence of skin conditions (such as eczema) than older children (Saunes *et al.* 2012). These findings are in line with that research. One explanation for this might be that younger children are more susceptible to skin issues since their immune systems and skin barriers are less established. The study also discovered that adolescents with enough economic level had more skin issues than those with low economic position. This result is unexpected and goes against earlier research that found a link between poor socioeconomic position and a higher prevalence of skin issues (Ofenloch *et al.* 2019). However, the cause of this unexpected discovery is unclear, and more study is required to examine the connection between adolescent asthmatics' socioeconomic level and skin issues. The study also

discovered that among young people with asthma, smoking had a substantial impact on skin issues. According to Thomsen and Sorensen (Thomsen and Sorensen 2010), smoking increases the chance of developing psoriasis, premature skin aging, and poor wound healing. Smoking has also been demonstrated to make asthma symptoms worse and raise the likelihood that both adults and children may get asthma (Lang *et al.* 2019). Since quitting smoking may benefit both respiratory and skin health, it should be a top focus in the therapy of asthma. Overall, the findings of this study shed light on the connection between skin conditions and asthma in young people, emphasizing the necessity of age-, socioeconomic-, and smoking-specific management strategies for asthma. These results need to be confirmed, and more study is required to fully comprehend the intricate interactions between skin issues and asthma in this population. According to the study's findings, the severity of skin issues among adolescents with asthma varies with age and socioeconomic level. Comparing adolescents aged 6-10 and 11-15, those aged 15–17 reported having less skin issues. According to earlier research (Bosma *et al.* 2021), younger children with asthma have a higher prevalence of skin conditions (such as eczema) than older children. These findings are in line with that research.

One explanation for this might be that younger children are more susceptible to skin issues since their immune systems and skin barriers are less established. The study also discovered that adolescents with enough economic level had more skin issues than those with low economic position. This result is unexpected and goes against earlier research that found a link between poor socioeconomic position and a higher prevalence of skin issues (Gaitanis *et al.* 2012). However, the cause of this unexpected discovery is unclear, and more study is required to examine the connection between adolescent asthmatics' socioeconomic level and skin issues. The study also discovered that among adolescents with asthma, smoking had a substantial impact on skin issues. Smoking has been linked to a number of skin issues, including psoriasis, delayed wound healing, and accelerated skin aging (Morita *et al.* 2007). Smoking has also been demonstrated to make asthma symptoms worse and raise the likelihood that both adults and children may get asthma (Lang *et al.* 2019). Since quitting smoking may benefit both respiratory and skin health, it should be a top focus in the therapy of asthma. Overall, the findings of this study shed light on the connection between skin conditions and asthma in adolescents, emphasizing

the necessity of age-, socioeconomic-, and smoking-specific management strategies for asthma. These results need to be confirmed, and more study is required to fully comprehend the intricate interactions between skin issues and asthma in this population. The results of this study are in line with other research, which has demonstrated that younger children have asthma symptoms more frequently and more severely than adolescents and older children (Martin *et al.* 2022; Triasih *et al.* 2023).

According to Yeh and Schwartzstein (Yeh and Schwartzstein. 2009), this may be because younger children have smaller airways and weaker respiratory muscles, which can make it more difficult for them to control their asthma symptoms. Younger children's immune systems may also be less developed, which could further increase their vulnerability to asthma (Jain 2020). According to earlier research (Trivedi and Denton 2019, Dharmage *et al.* 2019), there were no significant differences in asthma and allergy symptoms between male and female adolescents with asthma in this study. Other research, however, have shown contradictory findings, with some indicating that males have a higher frequency of asthma than females do (Fuseini and Newcomb 2017, Colombo *et al.* 2019). The variations in the results could be the result of various study populations and techniques. This study's findings about the relationship between income and asthma prevalence and severity are in line with earlier research (Hancox *et al.* 2004, Chen *et al.* 2016).

According to some research (Pacheco *et al.* 2014, Sullivan *et al.* 2020), there may be a link between factors including poor living conditions, exposure to environmental contaminants, and restricted access to healthcare in lower socioeconomic communities and an increase in the prevalence and severity of asthma. These results underline the necessity of social determinants of health-focused initiatives to lessen the impact of asthma in underserved communities. According to other earlier studies (To *et al.* 2012, Louisias and Phipatanakul 2017), there was no significant correlation between family size and asthma prevalence or severity in our study. Other studies, however, have produced contradictory findings, some of which indicate a higher prevalence of asthma in bigger families (Kirenga *et al.* 2019). The variations in the results could be the result of various study populations and techniques. According to other earlier research (Lin *et al.* 2011,

Lawson *et al.* 2017), there was no significant correlation between past illnesses and the prevalence or severity of asthma in our study. Other studies, however, have shown contradictory findings, with some indicating an association between past respiratory infections and an increased risk of developing asthma (Mohammad and Brough 2019). The variations in the results could be the result of various study populations and techniques. This study's findings regarding the relationship between smoking and asthma prevalence and severity are in line with earlier research (Sturm *et al.* 2004, Cerveri *et al.* 2012). According to some research, smoking may make asthma symptoms worse by weakening the lungs and harming the airways (Lin and Li 2023). These results emphasize the significance of preventing smoking beginning and encouraging smoking cessation among asthmatic adolescents. The prevalence and severity of nasal issues, skin issues, asthma, and allergy symptoms among children and adolescents with asthma are useful findings from this study. The results, which are in line with earlier research, highlight the need of addressing social determinants of health and reducing smoking initiation in order to lessen the burden of asthma in communities. Future studies are required to determine the best therapies to address these issues and enhance the management of asthma in children and adolescents.

The purpose of the current study was to determine whether certain asthma and allergy symptoms in children and adolescents with asthma are related to different demographic and lifestyle characteristics. The findings show that different age groups experience different levels of severity for particular asthma and allergy symptoms, with younger children experiencing worse symptoms. This result is in line with other research (Fuhlbrigge *et al.* 2001, Gupta *et al.* 2008), which demonstrated that a younger age is a significant risk factor for hospitalization and asthma exacerbations. Contrary to other earlier research (Huang *et al.* 1999, Almqvist *et al.* 2008), the current investigation did not discover any statistically significant differences in the particular asthma and allergy symptoms between male and female adolescents with asthma. However, this outcome is consistent with recent research that demonstrated no appreciable variations between genders in the severity of asthma symptoms (Caraballo *et al.* 2016).

The study also looked at how specific asthma and allergy symptoms were affected by economic position, and the findings showed that children and adolescents from wealthier households had symptoms that were more prevalent and severe. This result is in line with earlier studies (Poyser *et al.* 2002, Gong *et al.* 2014) that showed a relationship between socioeconomic status and asthma prevalence and severity. Children from less affluent families might have less access to healthcare, environmental asthma triggers, or preventative treatments, which could lessen the severity of their symptoms.

In line with several earlier investigations, the study did not detect a significant effect of the occurrence of prior illnesses on certain asthma and allergy symptoms. The results may have been impacted by the fact that the current study did not assess the effect of certain comorbidities on the severity of asthma symptoms (Novelli *et al.* 2018, Mahdavian *et al.* 2018). The last finding was that smoking was a significant risk factor for particular asthma and allergy symptoms in asthmatic adolescents. This finding is in line with earlier studies that showed smoking has negative impact on asthma symptom management and severity. In order to enhance symptom control and general health in adolescents with asthma, it is important to stop smoking (Gilliland *et al.* 2006; Jones *et al.* 2016). Overall, the present study offers insightful information about the lifestyle and demographic variables that affect particular asthma and allergy symptoms in children and adolescents with asthma. The results point to the need for targeted therapies that improve asthma symptom control and reduced morbidity in younger children, those from lower socioeconomic backgrounds, and smokers.

The study's findings show that children and adolescents with asthma from various age groups and socioeconomic backgrounds have variations in the characteristics linked to their current wheeze. Particularly, compared to earlier age groups, children aged 6 to 10 years demonstrated more severe variables related to present wheeze. This result is in line with earlier research (Carroll *et al.* 2012), which showed that a younger age is a significant risk factor for asthma exacerbations. The prevalence and severity of factors linked to present wheeze were also higher in adolescents from higher socioeconomic class, which is consistent with the socioeconomic gradient in asthma prevalence and severity seen in many countries (Pearce *et al.* 2007). Interestingly, there was no discernible difference in

the risk variables for present wheeze across asthmatic male and female adolescents. This result conflicts with other earlier studies that suggested a link between feminine gender and more severe asthma (Zein and Erzurum 2015). It is crucial to keep in mind that the current study only looked at variables linked to current wheezing; hence, other asthma symptoms and outcomes may potentially vary between male and female adolescents. It is also notable that there was no discernible impact of previous diseases or family size on the risk variables for present wheeze. This shows that, at least temporarily, these characteristics may not be substantial risk factors for asthma exacerbations in this cohort. To completely understand the impact of prior diseases on asthma outcomes, more research is required. It is crucial to keep in mind that the current study only evaluated the existence of prior diseases, not their severity or duration. The strong impact of smoking on the elements linked to present wheeze emphasizes the significance of helping adolescents with asthma stop smoking. Healthcare professionals should give smoking cessation programs top priority for their adolescentage asthma patients who smoke because smoking is a known risk factor for asthma exacerbations and poor asthma control (National Center for Chronic Disease Prevention and Health Promotion (US) 2014). Overall, the study's findings offer crucial new understandings into the factors that contribute to asthmatic children and adolescents' present wheeze and emphasize the significance of taking age and socioeconomic status into account when addressing asthma management and exacerbations in this demographic.

6. CONCLUSION

In order to better understand the prevalence of AA among children and adolescents seeking healthcare in the city of Mosul, this study looked into the incidence of AA among those children and adolescents who visited health centers in Mosul, Iraq. It also examined the relationship between demographic information and the incidence of AA. A significant portion of adolescents reported having skin concerns, and the study indicated that practically all children and adolescents had nasal problems, with the severity of asthma issues being quite low. Children and adolescents with AA were shown to experience asthma and allergy symptoms more frequently and more severely depending on their age, smoking status, and economic standing. The results of this study could help medical personnel in Mosul, Iraq, prevent and manage AA among children and adolescents. To provide a more thorough understanding of AA and its risk factors in this population, more study is required.

6.1. Recommendations

According to the study's findings, health facilities in Mosul, Iraq, should take action to lower the incidence and severity of allergic asthma in children and adolescents. This can be accomplished through promoting healthy lifestyle behaviors, increasing public awareness of the value of early diagnosis and treatment of allergic asthma, and educating people on the causes and triggers of asthma. Additionally, it's critical to offer routine exams and follow-up care to keep track of the health of children and adolescents who suffer from asthma and allergies. The factors that contribute to the higher prevalence and severity of allergic asthma in adolescents from higher socioeconomic backgrounds should also be determined and addressed. This can involve taking steps to enhance air quality, lessen exposure to allergens both indoors and outside, and support healthy living conditions. Health facilities should think about creating and executing focused treatments to lower the prevalence of asthma and allergy in adolescentage smokers. The study also emphasizes the need for more analysis of the prevalence and incidence of allergic asthma in Iraqi children and adolescents. Future research can concentrate on determining the precise risk factors that lead to allergic asthma development and evaluating the efficacy

of treatments meant to lessen the condition's prevalence and severity. Overall, the study's conclusions have significant policy and healthcare implications for Iraq and other nations that have comparable difficulties in treating allergic asthma in children and adolescents.

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APPENDICES

APPENDIX 1. Questionnaire

APPENDIX 2. Ethics CommIttee In Iraq

APPENDIX 3. Author permission to use the scale

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APPENDIX 4. Editing certificate

CURRICULUM VITAE

Personal Information

Name and Surname : Ahmed Mahdi Saleh SALEH