People`s Democratic Republic of Algeria
Ministry of High Education and Scientific Research
Abbes Laghrour University, Khenchela
Faculty of Natural and Life Sciences
Department of Ecology and Environment

الجمهورية الجزائرية الديمقراطية الشعبية
وزارة التعليم العالي والبحث العلمي
جامعة عباس لغرور خنشلة
كلية علوم الطبيعة والحياة

Academic Master's Thesis

Domain: Natural and life sciences

Branch: Ecology and environment

Submitted in Partial Fulfillment of The Requirements for a Master's Degree in Fundamental and applied ecology

Pollinosis and Airborne Pollen in the Urban Area of Zoui (Ouled Rechache, khenchela)

Presented by: **BELKHIRI Houda**

Committee:

Chairperson		Prof	Khenchela University
Supervisor	BOUCHAMA Khaled	MCA	Khenchela University
Examiner		MCA	Khenchela University

Academic year: 2023/2024

Dedication

I dedicate this work

To my dear Father and Mother !

Words will never be able to express the depth of my respect,gratitude, and eternal love. Thank you for always being there for me, a great support throughout my studies. This thesis is only the result of your advice and encouragement. Your prayers have been a great support throughout my studies.

To all the teachers from the BIOLOGY department who helped me throughout our university curriculum in particular our supervisor Dr. Bouchama Khaled for his valuable advice and the help he gave me, to the critical and constructive look at this work, the quality of its supervision during the preparation of this dissertation

To my beloved family and friends, thank you for your unwavering support, patience, and love. Your faith in me has been a constant source of motivation and strengthg.

BELKHIRI.HOUDA

Acknowledgements

First and foremost, I thank God Almighty, who has guided us throughout our lives, who has allowed us to learn and reach this far in our studies, and who has given us the courage and patience to overcome all the difficult moments. It is through His guidance that we have been able to complete this humble work.

Ithank my father!
Words will never be able to express the depth of my respect,gratitude, and eternal love. Thank you for always being there for me, a great support throughout my studies.

Ithank my mother!
Because this thesis is only the result of your advice and encouragement. Your prayers have been a great support throughout my studies

My sincere thanks to my supportive supervisor, Mr. Bouchama K, for his dedication during my supervision, his guidance, his valuable advice, and his continuous support throughout the completion of this work.

Iwoud like to express my gratitude to all the teachers in my ecology and environment specialization.

And **I thank** the members for their presence, guidance, and instructions. I also extend my gratitude to all the individuals who have contributed to the completion of this work, whether near or far.

BELKHIRI.HOUDA

Abstract

Allergies are a growing public health concern, with environmental and demographic factors playing a crucial role in their prevalence. This study aimed to investigate the impact of wind direction, local vegetation, and demographic characteristics on the incidence of pollinosis in the urban area of Zouï, Khenchela, Algeria. An epidemiological survey was conducted on 270 individuals residing in Zouï city, collecting data on allergy symptoms, potential causes, and related factors. The results revealed a high prevalence of allergies in the region, with 45.2% of participants experiencing symptoms at least once a year. Dust was identified as the primary cause of allergies (38.7%), followed by chemical products (27.6%) and plants (16%). Wind patterns, particularly the predominant northwest winds, were found to play a significant role in transporting allergens from forested areas and agricultural fields into Zouï, contributing to the high allergy incidence across different seasons. Age-related differences in allergy susceptibility were observed, with individuals aged 15-20, 30-40, and 50-60 years exhibiting heightened sensitivity to chemical products, dust (containing pollen), and plant allergens. This increased sensitivity could be attributed to factors such as occupational exposure, lifestyle patterns, and age-associated changes in the immune system. Furthermore, individuals spending 6 hours per day outdoors were found to be the most susceptible to allergies, potentially due to increased exposure to environmental allergens during peak allergen levels or specific time frames. The study also highlighted the importance of medical intervention and treatment adherence, with 68.9% of participants consulting a doctor and 89.3% reporting improvement after completing their prescribed treatment.

Keywords : Allergies, Pollinosis , Epidemiological survey , Immune system changes

Symptom improvemen .

Résumé

Les allergies représentent un problème de santé publique croissant, les facteurs environnementaux et démographiques jouant un rôle crucial dans leur prévalence. Cette étude visait à étudier l'impact de la direction des vents, de la végétation locale et des caractéristiques démographiques sur l'incidence du pollinose dans la zone urbaine de Zouï, Khenchela, Algérie. Une enquête épidémiologique a été menée auprès de 270 personnes résidant à Zouï, recueillant des données sur les symptômes allergiques, les causes potentielles et les facteurs associés. Les résultats ont révélé une forte prévalence des allergies dans la région, 45,2% des participants ayant présenté des symptômes au moins une fois par an. La poussière a été identifiée comme la principale cause d'allergies (38,7%), suivie des produits chimiques (27,6%) et des plantes (16%). Les régimes des vents, en particulier les vents dominants du nord-ouest, ont joué un rôle important dans le transport des allergènes des zones boisée forestière et des champs agricoles vers Zouï, contribuant ainsi à la forte incidence des allergies à différentes saisons. Des différences liées à l'âge dans la sensibilité aux allergies ont été observées, les personnes âgées de 15 à 20 ans, de 30 à 40 ans et de 50 à 60 ans présentant une sensibilité accrue aux produits chimiques, à la poussière (contenant du pollen). Cette sensibilité accrue pourrait être attribuée à des facteurs tels que l'exposition professionnelle, les modes de vie et les changements liés à l'âge du système immunitaire. Les personnes passant 6 heures par jour à l'extérieur ont été les plus sensibles aux allergies, potentiellement en raison d'une exposition accrue aux allergènes pendant les périodes de pointe ou à des moments spécifiques. L'étude a également mis en évidence l'importance de l'intervention médicale et de l'observance du traitement, 68,9% des participants ayant consulté un médecin et 89,3% ayant signalé une amélioration après avoir terminé leur traitement prescrit.

Mots clés : Allergies, Pollinose , Enquête épidémiologique , Modifications du système immunitaire. Amélioration des symptômes .

الملخص

تمثل الحساسية مشكلة صحية عامة متنامية، حيث تلعب العوامل البيئية والديموغرافية دورًا حاسمًا في انتشارها. هدفت هذه الدراسة إلى دراسة تأثير اتجاه الرياح والغطاء النباتي المحلي والخصائص الديموغرافية على حدوث مرض التلقيح في المنطقة الحضرية لمدينة الزوي، خنشلة، الجزائر. وتم إجراء مسح وبائي على 270 شخصا من المقيمين في الزوي، لجمع بيانات حول أعراض الحساسية والأسباب المحتملة والعوامل المرتبطة بها. وكشفت النتائج عن ارتفاع معدل انتشار الحساسية في المنطقة، حيث يعاني 45.2% من المشاركين من الأعراض مرة واحدة على الأقل في السنة. تم تحديد الغبار باعتباره السبب الرئيسي للحساسية (38.7%)، تليها المواد الكيميائية (27.6%) والنباتات (16%). لعبت أنماط الرياح، وخاصة الرياح الشمالية الغربية السائدة، دورا هاما في نقل المواد المسببة للحساسية من مناطق الغابات والحقول الزراعية إلى زوي، مما ساهم في ارتفاع معدلات الإصابة بالحساسية في مختلف المواسم. وقد لوحظت اختلافات مرتبطة بالعمر في قابلية الإصابة بالحساسية، حيث أظهر الأشخاص الذين تتراوح أعمارهم بين 15 إلى 20 عامًا، ومن 30 إلى 40 عامًا، ومن 50 إلى 60 عامًا حساسية متزايدة للمواد الكيميائية والغبار (الذي يحتوي على حبوب اللقاح). ويمكن أن تعزى هذه الحساسية المتزايدة إلى عوامل مثل التعرض المهني وأنماط الحياة والتغيرات المرتبطة بالعمر في جهاز المناعة. كان الأشخاص الذين يقضون 6 ساعات يوميًا في الخارج أكثر عرضة للإصابة بالحساسية، ربما بسبب زيادة التعرض لمسببات الحساسية خلال فترات الذروة أو في أوقات محددة. وسلطت الدراسة الضوء أيضًا على أهمية التدخل الطبي والالتزام بالعلاج، حيث قام 68.9% من المشاركين باستشارة الطبيب و89.3% أبلغوا عن تحسن بعد استكمال العلاج الموصوف لهم.

الكلمات المفتاحية: الحساسية، حبوب اللقاح، التقصي الوبائي، التغيرات في جهاز المناعة تحسين الأعراض

List Of Abbreviation

- ✓ **ANES:** Agence Nationale de Sécurité Sanitaire de l'Alimentation
- ✓ **ARIA** : Allergic Rhinits and its Impact on Asthma
- ✓ **CENEAP** : Centre National d'Etude et d'Analyse pour la Population et le Development
- ✓ **HDM**: House Dust Mites
- ✓ **IgE** :Immunoglobuline E
- ✓ **OAS** :Oral Allergy Sysdrome
- ✓ **OESRP** :Office of Environmental Stundies and Regional Planing
- ✓ **PADD** :Plan d'Aménagement et de Développement Durable
- ✓ **RMPDRM** :Reviewing the Master Plus for Development and Reconstruction of the Municipality
- ✓ **WHO :** The World Health Organization

Table of contents

Chapter II: Materials and methods

Chapter III:Results and Discussion

Conclusion

Bibliographic references

List of figures

List of figures

Introduction

Pollinosis refers to the onset of respiratory symptoms, such as rhino-conjunctivitis and/or asthma, triggered by inhaling pollen to which an individual is sensitized **(Bartra, 2009)**. In addition to common symptoms such as shortness of breath, coughing, sneezing, and itching, some individuals may experience fatigue, headaches, sinus pressure, and changes in smell and taste **(Jacques, 2015).**

Pollen, the main trigger of allergies in our environment, emanates from plants in the form of tiny grains invisible to the naked eye **(Richard, 2020).** The potentially allergenic flora of Algeria amounts to 171 Angiosperm species **(Choukry, 2017).**

According to the findings from an epidemiological study, a substantial 51.9% of individuals diagnosed with allergic rhinitis demonstrate sensitivity to some form of pollen **(Bartra, 2009)**. In the Mediterranean region, pollen-induced allergic reactions affect more than 10% of the population **(D'Amato, 1998).**

While it may not be possible to avoid contact with pollen grains and being affected by them, it is possible to reduce exposure to them. Vaccination, biological monitoring, and studying how pollen is transported remain effective tools for determining the concentration, types, as well as the grains that cause pollen allergies, and identifying their source, which is likely to be affected by factors that are mostly human-made, such as pollution, the presence of numerous factories, and transportation. Traffic and other natural factors, including wind direction, humidity, precipitation also play a role **(Jae-Won Oh, 2018).** According to the World Health Organization, allergy is classified as the 4th most common chronic disease, as it is a real public health problem due to its prevalence and its consequences on quality of life **(Aurélie, 2009).**

The absence of a coordinated pollen monitoring calendar in Algeria poses challenges on two fronts. Firstly, it hinders allergists from accurately assessing the timing of pollen release and its correlation with allergic reactions in patients, thus impacting diagnostic accuracy. Secondly, it prevents allergic individuals from proactively taking measures to mitigate pollen-related effects. Early treatment during peak pollen seasons can inadvertently trigger hypersensitivity, worsening symptoms such as asthma attacks, potentially endangering the lives of affected individuals.

An epidemiological survey can provide data on the prevalence of pollinosis in a specific population or region. This information is crucial for understanding the burden of the disease and its impact on public health **(Hashimoto et *al.*, 2007)**.

Epidemiological studies can help identify potential risk factors associated with pollinosis, such as environmental factors (e.g., air pollution, climate), genetic predisposition, or lifestyle factors. Understanding these risk factors can aid in the development of preventive strategies and targeted interventions **(Corsico et *al.*,2000).** Epidemiological surveys can map the geographic distribution of pollinosis cases, which can be correlated with the distribution of potential allergens (e.g., pollen-producing plants) and other environmental factors **(McInnes et *al.*,2017).**

In this context, the aim of this study is collecting demographic and health data by conducting an epidemiological survey in the urban area of Zoui (Ouled Rechache, khenchela) to identify subgroups within the population that are more vulnerable to pollinosis, such as individuals with pre-existing respiratory conditions or those living in areas with higher pollen concentrations. By conducting an epidemiological survey that considers wind direction and vegetation, we can gain comprehensive insights into the complex interplay of environmental factors contributing to pollinosis.

The manuscript we are proposing is organized as follows:

-The first part is devoted to a synthesis of bibliographic data on pollinosis, providing an overview of the current understanding and research on this condition.
-The second part presents the methodology and details of the epidemiological survey conducted, including the study design, data collection methods, and relevant demographic and environmental information about the region under investigation.
-The third part is dedicated to presenting the results obtained from the epidemiological survey and discussing their implications.

1. Pollinosis

1.1. Overview about allergy

The history of allergy allergic diseases reaches back much further than commonly believed, with references dating back to ancient times. Menes, a pharaoh from around 2650 BCE, is recorded as one of the earliest known individuals to suffer from an allergy, specifically to hymenopteran insect venom. Even renowned figures such as Hippocrates and Galen recognized the link between cow or goat milk consumption and digestive issues and urticaria, indicating an early understanding of food allergies. These historical accounts underscore the ancient awareness of the body's adverse reactions to certain substances **(Mondoulet, 2005).** However, allergies were not clearly defined until the early 20th century. In 1906, the term "allergy" was coined by Von Pirquet and his collaborator Béla Shick **(Molina, 1995).**

1.2. Definition of pollinosis

Over the last fifteen years, there has been a significant increase in the prevalence of allergic diseases. The World Health Organization (WHO) now categorizes allergic diseases as the fourth most common chronic illness. diagnosis of allergies involves pinpointing the allergic source of symptoms and identifying the allergens responsible for the reaction **(Didier and *al.*, 2006).**

Pollen allergy or pollinosis refers to allergic manifestations caused by contact of the nasal, bronchial or ocular mucous membranes with pollen from trees, grasses and other herbaceous plants **(Silly and Pomboucq, 2014).**

The allergenic capacity of pollen varies depending on the size of the grains, the concentration of allergenic proteins, and their dispersion ability **(Charpin, 2004).** If transport takes place by wind, pollination is much more random, the plant, called anemophilous, expends a lot of energy producing large quantities of pollen and does not possess attractive lures (**Jacques, 2015**).

1.3. Impacts of allergic diseases

1.3.1. Health impact

Actually, the phyto-allergic phenomenon has taken a worrying pace in the Setifian High Plains (Setif change to Algeria). Due mainly to many allergy pollen ornamentals that negatively affect the air quality and life of the inhabitants **(Chermat et *al.*,2019).**

1.3.2. Impact on quality of life

Allergies caused by pollinosis influence workers' physical and psychological conditions. These changed conditions also influence the workers' human error. Authors assumed that human performance was based on cognitive activities, that is, self-monitoring of allergies and work errors **(Yamamoto and Koyatsu, 2003).**

1.4. Causes and Triggers

1.4.1. Pollen Allergens

Most of the clinically relevant pollen allergens are produced by wind-pollinated trees belonging to only four different orders, which show an almost worldwide distribution (**Pablos et *al.*, 2016)**. In the case of pollinosis, different parts of the pollen grains contain numerous allergens responsible for allergic manifestations **(Abou, 2009).**

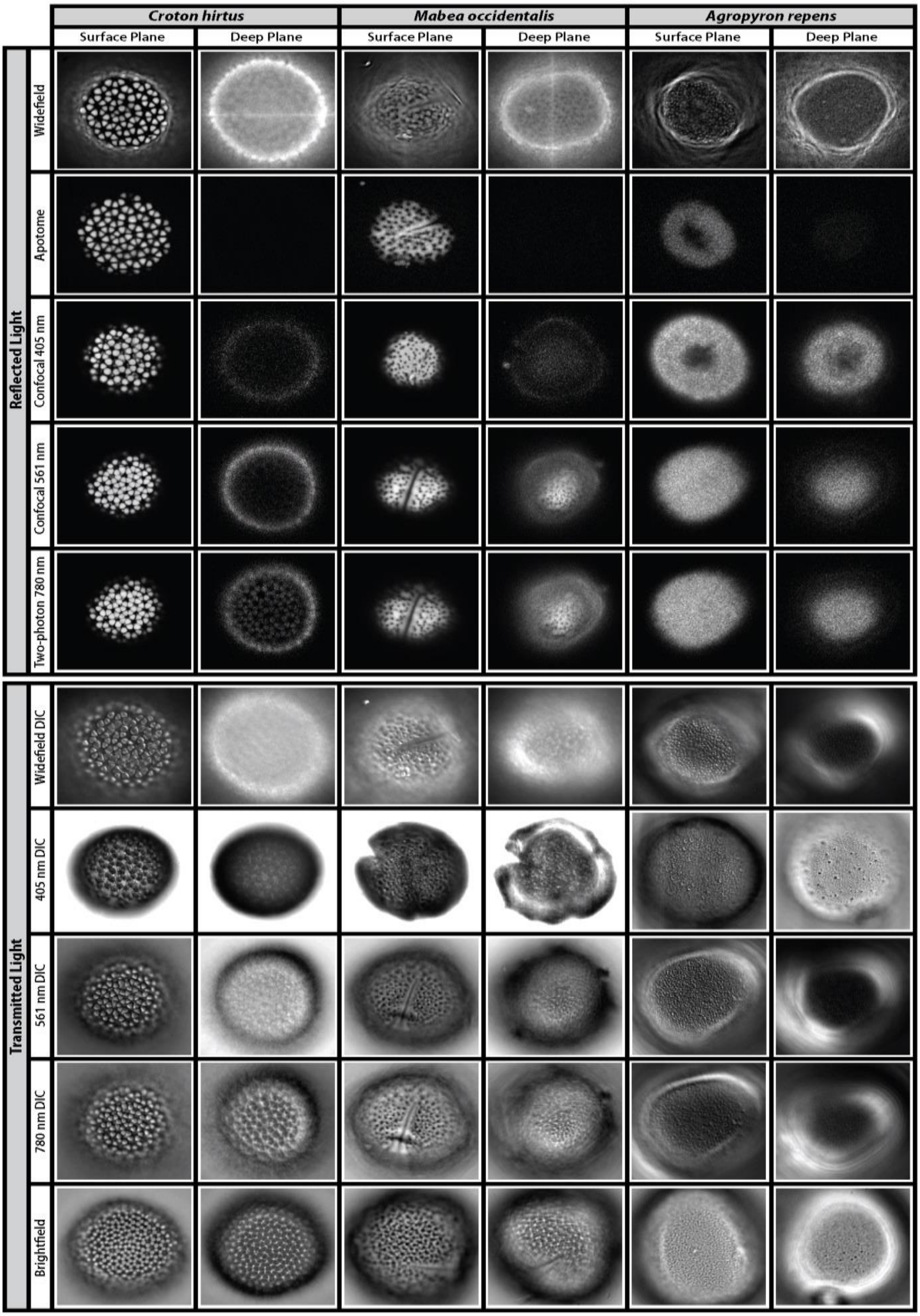


Figure 01: The surface texture of pollen grains **(Sivaguru et *al*., 2012).**

1.5. Environmental factors

Allergic reactions are considered as multifactorial, heterogeneous disorders caused by an interaction of environmental and genetic factors and can express themselves in many different organs **(Jenerowicz et *al.*, 2012).** Pollution is often associated with allergic rhinitis, allergic sensitization, and autoimmunity and can have detrimental health effects involving the immune system **(Wu et *al.*, 2021).** In addition, by inducing airway inflammation, pollutants may overcome the mucosal barrier and so 'prime' allergen-induced responses. In other words airway mucosal damage and impaired mucociliary clearance induced by air pollution may facilitate the access of inhaled allergens to the cells of the immune system **(D'Amato, 2002).**

1.5.1. Indoor Allergens

HDM: house dust mites, molds, and pet dander are common examples of indoor allergens **[18].** Indoor allergens cause more severe allergy symptoms than outdoor allergens **[18].** Longitudinal data collected between 2006 and 2017 suggest that exposure to molds is tightly linked to the development and exacerbation of symptoms of AR in children **(Wu et *al.*, 2021).**

1.5.2. Outdoor Exposures

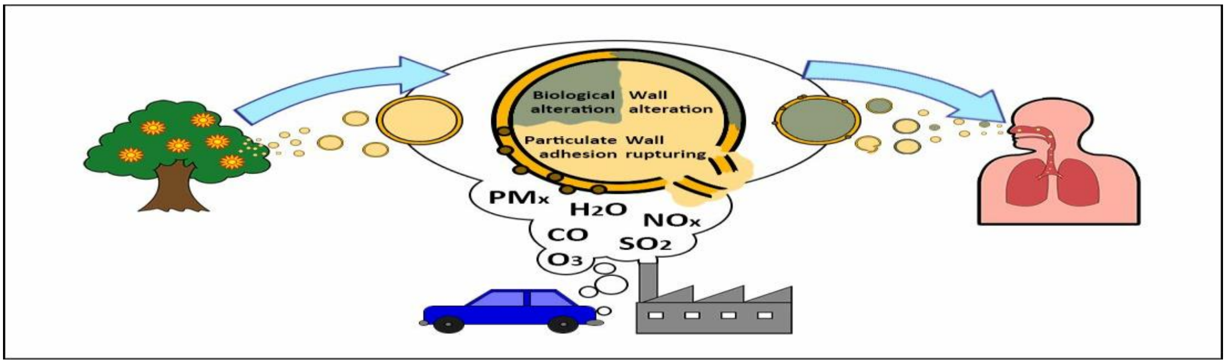


Figure 02: Graphical Abstract represent interaction between air pollutants and pollen **(Capone et *al.*, 2023).**

- Air pollution: For years, urban air pollution has been a matter of research as an important extrinsic, environmental etiologic agent **(Jenerowicz et *al.*, 2012)**, because atmospheric pollutants like PMx, NO_2, SO_2, and CO have a direct effect on the physical and chemical properties of pollen grains **(Capone et *al.*, 2023).**

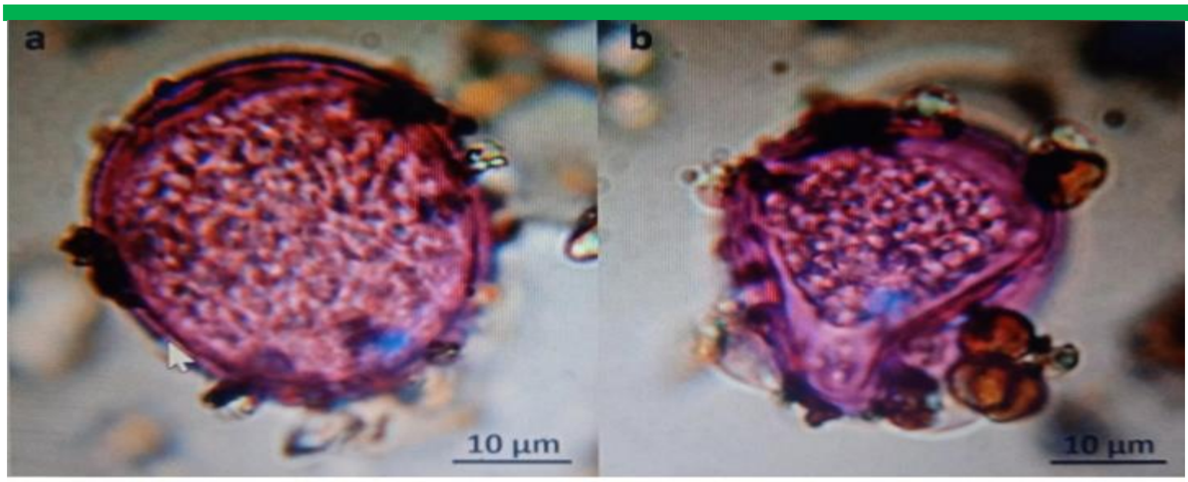


Figure 03: Examples of Poaceae pollen grains, with particulate matter adhered to the external surface: (a) integer pollen grain, (b) deformed pollen grain with attached fungal spores. Pollen grains have been stained with basic fuchsine **(Capone et *al.*, 2023).**

-Climatic changes: Climate change influences the development of allergic diseases and influences pollen productions that induce allergic manifestations **(Choi et *al.*, 2021)**. the pollen season intensity is infl uenced by rainfall in the previous weeks. Changes on the amount of allergenic pollen, pollen allergenicity, plant distribution and pollen seasons are considered one of the more important ways that climate change has an impact on human health (**Stach et *al.*, 2007)**

- Airborne allergens: These are among the most extensively studied environmental factors regarding the source of potential risk for sensitization and manifestation of atopy, in consideration of both the airways and skin. Cross-sectional studies regarding children and adults strongly suggest that there is a close association between allergen exposure and sensitization to specific allergens **(Jenerowicz et *al.*, 2012)**

1.6. Genetic Predisposition

A change in the genetic predisposition is an unlikely cause of the increase in allergic diseases because genetic changes in a population require several generations. The best-established risk factor for nasal allergy is family history of allergy, especially nasal allergy. Susceptibility genes are genes in which only a few mutational changes may lead to sensitivity to certain diseases **(Arakawa and Morikawa, 2004).** it can also be said that a change in the genetic predisposition is an unlikely cause of the increase in allergic diseases because genetic changes in a population require several generations **(D'amato et *al.*, 2005).**

1.7.Types of Pollinosis

Exposure to pollen present in ambient air causes allergic reactions in humans called pollinosis or hay fever at the level of contact areas: respiratory mucous membranes, eyes, and more rarely, they can be responsible for skin reactions, such as eczema or hives **(ANSES, 2014).** Respiratory allergy linked to pollen presents in two main forms: rhinitis allergic or hay fever, most often, *al*lergic asthma, more rarely. Not all pollens are allergenic and may or may not be the cause of allergic manifestations. This depends on their allergenic potential, the sensitization of individuals following repeated exposures, and their ability to react to the allergens contained in these pollens **(Caillaud et *al.*, 2014).**

1.7.1. Seasonal Allergic Rhinitis

Hay fever presents with various symptoms including sneezing, nasal congestion or a runny nose, and itching. These symptoms serve as diagnostic criteria and encompass four primary elements: rhinorrhea (nasal discharge), nasal itching, sneezing (often in rapid succession), and nasal congestion. In children, a loss of smell (anosmia) constitutes a fifth element, albeit rarely observed **(Sophie et *al.*, 2018).**

1.7.2. Perennial Allergic Rhinitis

Perennial allergic rhinitis can be more difficult to diagnose than seasonal allergy, particularly if the patient presents with secondary symptoms of sinusitis and a "permanent cold." The most common allergen to account for perennial allergies symptoms is the house dust mite (*Dermatophagoides pteronyssinus*). Other common causes are animals, particularly cats, dogs, and horses. In some parts of the world, "typical" seasonal allergens are perennial in nature. Equally, symptoms of perennial rhinitis may not be present all year round. For these reasons a new classification has been put forward in the document on allergic rhinitis and its impact on asthma (ARIA) (**Bousquet et *al.*, 2001).**

1.7.3. Oral Allergy Syndrome

-OAS is a form of a contact allergic reaction that occurs upon contact of the mouth and throat with raw fruits or vegetables. The most frequent symptoms of OAS include itchiness or swelling of the mouth **(James et *al.*, 2010).**

1.8. Symptoms and Diagnosis

1.8.1. Symptoms

Persons with allergies present with symptoms that often are the result of alterations in the nervous system. Neuronally based symptoms depend on the organ in which the allergic reaction occurs but can include red itchy eyes, sneezing, nasal congestion, rhinorrhea, coughing, bronchoconstriction, airway mucus secretion, dysphagia, altered gastrointestinal motility, and itchy swollen skin (**Undem *et al.*, 2014).**

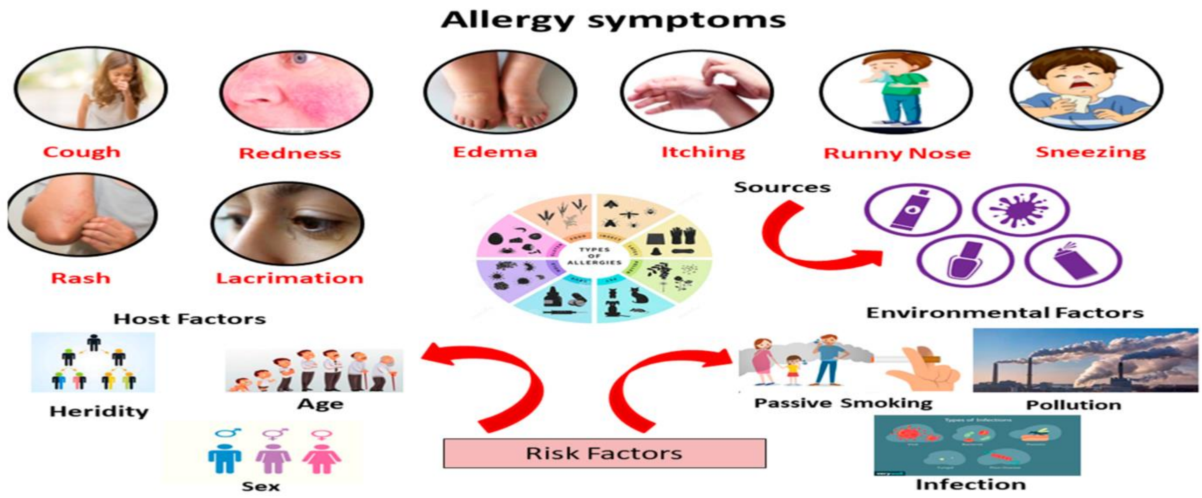


Figure 04: Symptoms and risk factors of allergic diseases **(Capone et *al.*, 2023)**

Organ involvement	Symptoms
Gastrointestinal tract	Infantile colic, irritable Vomiting Regurgitation Constipation Blood in stool, iron deficiency anemia Unstable defecation
Skin	Atopic dermatitis Urticaria Angioedema
Respiratory tract	Chronic cough Wheezing, bronchospasm

Figure 05: The most symptoms allergic **(Nedkova et *al.*, 2018).**

1.8.1.1. Nasal Symptoms

Nasal symptoms: It is due to allergic inflammation of the nasal mucosa, caused by inhalation of pollen. The symptoms that allow a diagnosis to be made are : runny nose (rhinorrhea), itchy nose (pruritus), sneezing (often in bursts), blocked nose (obstruction). A fifth element is very rare in the child, it is the loss of smell (anosmia) **(Jacques, 2015).**

1.8.1.2. Eye symptoms

The eyes feel red and irritated, accompanied by a sensation of sand in the eye **(Thibaudon, 1992)**. Consequently, a spring season with increased rainfall might offer some relief to individuals suffering from pollen allergies **(Schramm, 2021).**

1.8.1.3. Cough

Cough can be defined as a sudden, jerky and noisy exhalation causing following a deep inspiration. This expiration is active: it is accompanied by a contraction of the abdominal muscles **(Roche and Huchon, 2015).**

1.8.2. Diagnostic Tests

1.8.2.1. Skin tests (A prick test)

The allergist pricks superficially through a drop of allergenic extract deposited on the child's forearm, with standardized plastic or metal tips (prick tests). The prick must remain painless and do not bleed. The wheal type reaction occurs after 15 minutes; it is read in mm and compared to the negative control (glycerosaline solution) and to the positive control (histamine) **(Jacques, 2015).**

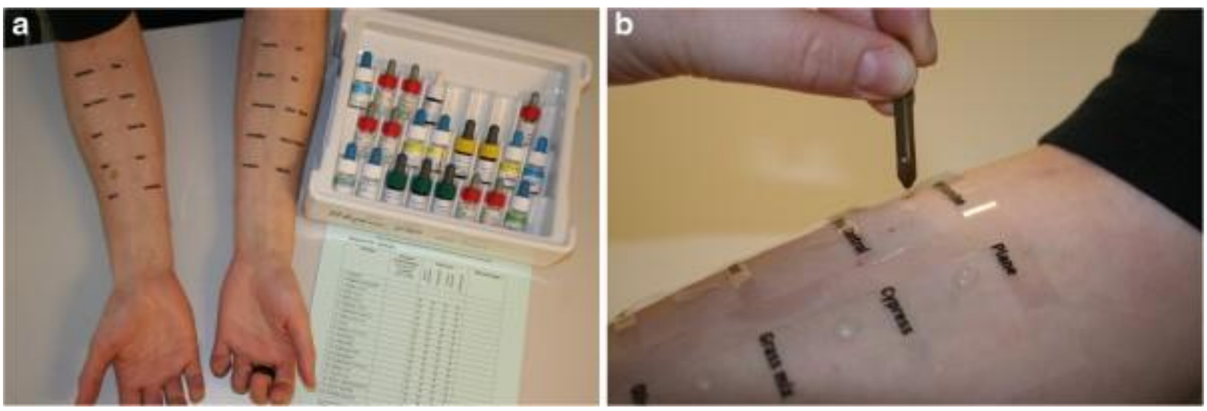


Figure 06: Skin prick test **(Heinzerling et *al.*, 2013).**

1.8.2.2. Intradermal Skin Test

Intradermal testing involves injecting a tiny amount of allergen into the outer layer under skin. This test may be used if the skin-prick test results are negative but an allergy is still suspected **(Jae-Won Oh, 2018).**

1.8.2.3. Allergy blood test

Blood tests are available that measure levels of immunoglobulin E (IgE) against specific allergens such as foods, inhalants, medications, latex, and venoms. These tests can confirm the diagnosis of an allergic disorder, supplementing a clinical history consistent with an immediate allergic reaction **(Siles, 2011).**

1.9. Epidemiology and Risk Factors

Although recent reports show a worldwide increase in allergic diseases during the past 10-20 years, few epidemiological studies on secular trend and the age-specific prevalence of allergic rhinitis have been carried out in **(Sakurai et *al*,. 1998)**. Pollinosis is one of the most common allergic diseases worldwide, affecting up to 30% of adults and up to 40% of children in some countries. The prevalence varies by geographic region, with higher rates in industrialized countries compared to developing nations. Pollinosis is more common in certain families and tends to run in allergic individuals **(Alnahas et *al*., 2023 ; Gutowska-Ślesik et *al*., 2023).**

- Genetic predisposition: Having a family history of allergies or asthma increases the risk. Environmental exposure: Living in areas with high levels of pollen from trees, grasses, or weeds can trigger symptoms **(Saulyte, et *al*., 2014; Alnahas et *al*., 2023).**

-Age: Pollinosis can develop at any age but is most common in childhood and adolescence. Gender: Males are more commonly affected in childhood, but the rates become similar in adulthood **(Alnahas et *al*., 2023 ; Gutowska-Ślesik et *al*., 2023).**

- Air pollution: Exposure to air pollutants like ozone, particulate matter, and diesel exhaust can worsen pollen allergy symptoms **(Alnahas et *al*., 2023).**

- Occupational exposure: Working in certain professions like farming, gardening, or landscaping increases pollen exposure risk **(Alnahas et *al*., 2023).**

- Climate change: Rising temperatures and increased carbon dioxide levels can lead to longer pollen seasons and higher pollen levels **(Sakurai and *al.*, 1998; Alnahas et *al.*, 2023).**

1.9.1. Age and Gender Differences

1.9.1.1. Allergy according to age group

The incidence of allergic asthma is highest in early childhood and steadily decreases with advancing age, while the incidence of non-allergic asthma is low until it peaks in late adulthood. After approximately 40 years of age, most of the new cases of asthma are non-allergi **(Pakkasela et *al.*, 2020).**

1.9.1.2. The prevalence of allergy according to Gender

Boys run a higher risk for atopy than girls but this gender difference is less pronounced in adulthood. The underlying mechanisms and the exact timing of this decrease in male/female ratio remain unclear **(Govaere et *al.*, 2007).**

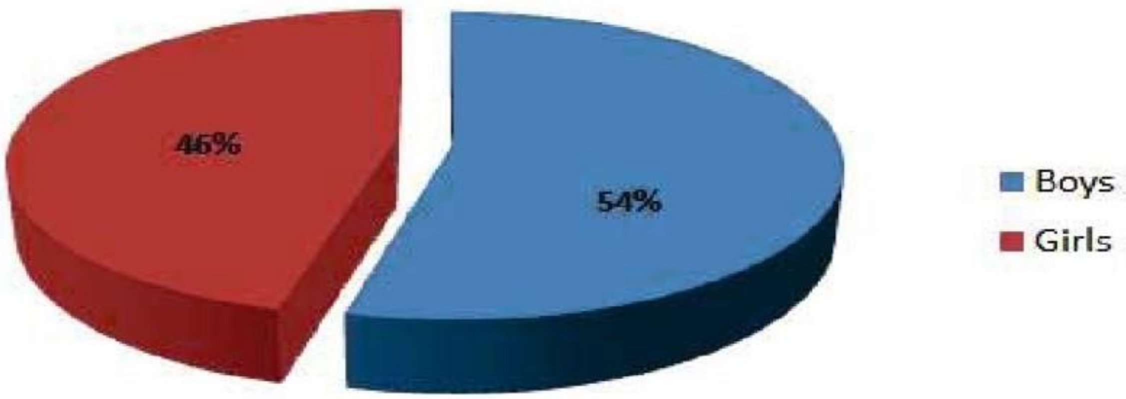


Figure 07: Gender distribution of infants with food allergy (%) **(Nedkova et *al.*, 2018).**

1.9.2. Geographic and Environmental Factors

Several studies showed that the variations in the prevalence of pollinosis among similar ethnic groups living in different environments (**von Mutius et *al.*, 1992; Williams, 1995)** and in different regions, as well as variations among populations from various socio-economic backgrounds **(Chen et *al.*, 2002; Goh*et et al.*, 1996)** all highlight the significance of environmental and social factors related to this issue. Various socio-economic indicators, environmental factors such as pollutants (aside from pollen) **(Hajat et *al.*, 2001; Nicolai et *al.*, 2003; Salvi, 2001)**, and meteorological conditions have been reported to be associated with the development of allergic pollen.

1.10. Management and Treatment

1.10.1. Avoidance and Environmental Control

The management of allergic diseases involves a combination of pharmacotherapy, immunotherapy, anti-IgE therapy, and avoidance measures (**Higaki et *al.*, 2012).** While complete avoidance of pollen is the ideal approach, it's often impractical. Controlling outdoor allergen exposure is more challenging than indoor allergens due to widespread dispersion. Strategies to reduce outdoor allergen exposure include staying indoors during high pollen and mold counts, using air filters, and avoiding outdoor activities like lawn mowing. Washing hands, faces, and hair after outdoor exposure can also help alleviate allergic reactions. There are ways to alleviate your reaction to the allergen **(Jae-Won Oh, 2018).**

- ✓ Wear a mask on high pollen count days.
- ✓ Keep windows closed on high pollen count days.
- ✓ Avoid the outdoors on dry, windy days.
- ✓ Avoid gardening during the peak of each allergy season **(Jae-Won Oh, 2018).**

1.10.2. Medication Therapy

The medical treatment of pollinosis involves different classes of drugs administered locally or by general route. They belong to three main classes, antihistamines, steroids and mast cell stabilizers. Since it is a relatively benign *al*so highly common disease, treatment options are limited by possible, even mild, side effects and by cost efficacy restriction. In the more severe forms of the condition, treatment efficacy remains unsatisfactory **(Harf, 2012).**

1.10.3. Immunotherapy

Severe pollen allergy symptoms can be relieved through immunotherapy. This treatment method is highly effective for both allergic rhinitis *al*lergic asthma **(Pence et *al.*, 1976)**. The key to its clinical effectiveness lies in administering appropriate doses of allergen extracts, which have been determined through controlled studies for many allergens. Immunotherapy works by triggering an early and temporary increase in regulatory T cells, which subsequently reduce both T cell hyperactivity allergic reactions **(Jae-Won Oh).**

1.11. Prevention and Public Health Measures

1.11.1. Pollen Monitoring and Forecasting

The monitoring section outlines advancements in phenological networks, remote sensing of vegetation cycles, and the emergence of aerobiology and aeropalynology sciences. It discusses pollen sampling instruments, counting techniques, and applications in agriculture, including the European Pollen Information System. Key data sources for aeropalynology include phenological observations, pollen counts, and remote sensing of vegetation activity. The primary challenge ahead is integrating these data into numerical pollen forecast systems. Decades of consistent monitoring efforts have generated extensive pollen concentration time series, offering valuable insights into pollen emission, transport, and deposition. New monitoring methods can now measure allergen content in pollen, with research findings expected to enhance operational pollen forecasts' quality **(Scheifinger et *al.*, 2013).**

1.11.2. Public Awareness and Education

Increasing the awareness for allergic symptoms is the key not only for the diagnosis but also for the optimal treatment. Therefore, education is an important component of prevention and control of allergic diseases **(Kalpaklioglu et *al.*, 2011).**

1.11.3. Environmental Policies and Regulations

The implementation of policies to reduce environmental allergic triggers can be an important adjunct to optimal patient care for allergic rhinitis and allergic asthma. Policies at the local level in schools and other public as well as private buildings can make an impact on disease morbidity **(Abramson, 2018).**

1.11.4. Wind direction and the distribution of pollen

The distribution of the sources and the wind direction play a very major role in determining the pollen concentration in the atmosphere **(Silva et *al.*, 2000)**

The direction of the wind plays also a crucial role in determining where pollen gets dispersed and concentrated.

-Source and sink areas: Pollen source areas are locations with high concentrations of pollen-producing plants, such as forests, grasslands, or agricultural fields. Sink areas are regions where pollen accumulates, often downwind from the source areas. The wind direction determines the trajectory of pollen transport from sources to sinks **(Silva et *al.*, 2000; Ciani et *al.*, 2020).**

-Long-distance transport: Certain weather patterns and wind systems can carry pollen over long distances, sometimes hundreds of kilometers away from the source. For example, pollen

from ragweed plants can be transported across the Atlantic Ocean by prevailing westerly winds**(Rojo et *al.*, 2015 ; Ciani et *al.*, 2020).**

-Urban versus rural areas: Wind patterns can lead to higher pollen concentrations in certain urban areas compared to rural regions. Cities often experience the "heat island effect," which can create local wind patterns that trap and concentrate pollen **(Ciani et *al.*, 2020).**

-Seasonal variations: The predominant wind directions can change throughout the year, affecting the distribution of different types of pollen during their respective blooming seasons. **(Ciani et *al.*, 2020).**

-Terrain effects: Topographic features like mountains, valleys, and large bodies of water can influence local wind patterns and, consequently, the deposition of pollen in those areas. **(Ciani et *al.*, 2020 ; Frisk et *al.*, 2023)**

1.12. Future Perspectives and Challenges

1.12.1. Climate Change and Pollinosis

Climate change is expected to have a significant impact on pollinosis, or pollen-induced allergic reactions. One of the key factors contributing to this phenomenon is the increase in atmospheric carbon dioxide (CO_2) levels due to human activities **(Jae-Won Oh, 2018).** suggests that as climate change progresses and CO_2 levels continue to rise, individuals with pollen allergies may experience heightened exposure to allergens from oak pollen. Consequently, they are likely to suffer from more severe allergic reactions, such as hay fever, asthma, and other respiratory issues.

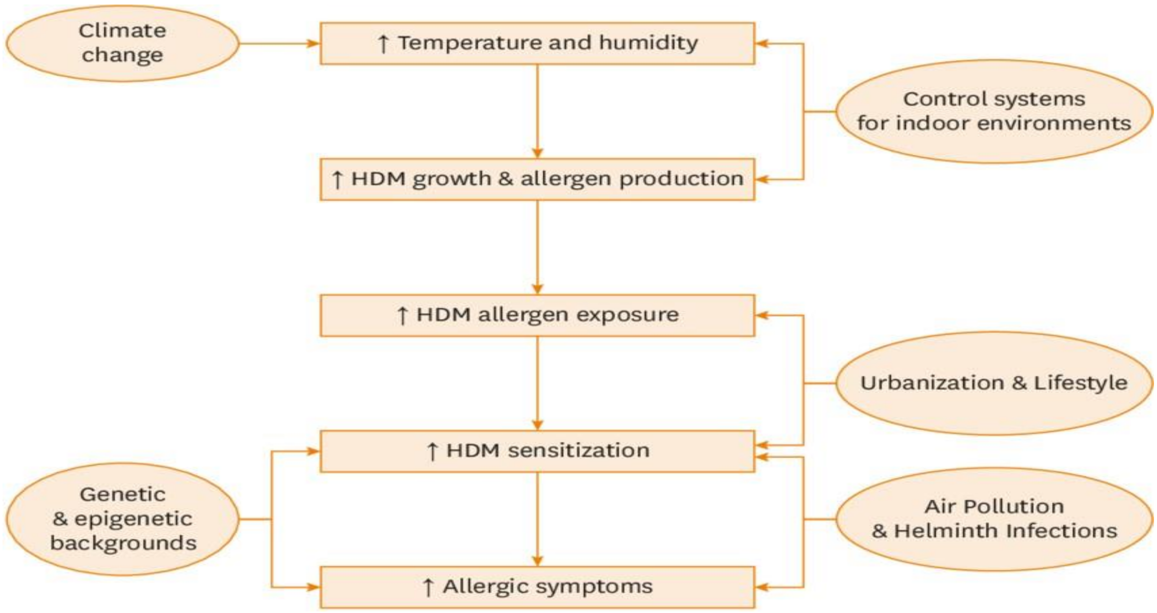


Figure 08: The relationship between climate change and the increase in allergy symptoms **(Beggs, P. J,2021**).

1.11.2. Emerging Allergens and Cross-Reactivity

Many different syndromes and associations due to cross-reactivity between aeroallergens and food allergens of plant, fungal and animal origin have been described. Significant examples are pollen-food syndromes or associations, along with mite-shrimp, cat-pork, and bird-egg syndromes, but rare or more complex clinical entities must also be discussed. It is important to underline the impact of relevant cross-reactivities between aeroallergens and food allergens and of molecular-based allergy diagnosis in clinical practice **(Ballmer-Weber et *al*., 2002).**

1.Presentation of the province of khenchela and the study area (Zoui).

1.1. Presentation of khenchela.

1.1.1. Description of khenchela.

Located in the eastern part of the country, at the foothills of the Aurès Mountains, within the geographical area between 6° 32' and 7° 34' East longitude and between 35° 7' and 35° 38' North latitude, the province of Khenchela is bordered (figure 1):

- to the north, by the province of Oum El Bouaghi;
- to the northwest, by the province of Batna;
- to the southwest, by the province of Biskra;
- to the south, by the province of El Oued;
- to the east, by the province of Tébessa.

Its territorial extent covers a total area of 9,715 km² **(OESRP, 2014)**, it has benefited from a diverse but hostile physical environment and holds one of the highest altitudes in northern Algeria, at 2,326 meters (Chelia) **(DPAT, 2012 in Ghedir and Kattoum, 2023).**

Figure 09: Geographical location of province of Khenchela **(OESRP,2014)**

1.1.2. The relief.

The terrain is shaped by altitude and slope, with the latter posing significant challenges for land development, especially in agriculture. Khenchela province features three distinct areas:

- **Northern High Plains:** Characterized by altitudes between 850 and 900 meters and gentle slopes (less than 3%).
- **Central Mountain Zone**: Includes the Aurès and Némenchas massifs, with Djebel Chélia reaching 2,169 meters, one of the highest peaks in the Algerian Atlas. Altitudes range from 1,000 to 2,169 meters, interspersed with narrow, northeast-trending valleys.
- **Southern Steppe and Presaharian Plains:** Includes areas below sea level (e.g., Oglat El Barra at -26 meters) and features relatively flat topography within the Melghir basin and the Grand Erg Oriental.

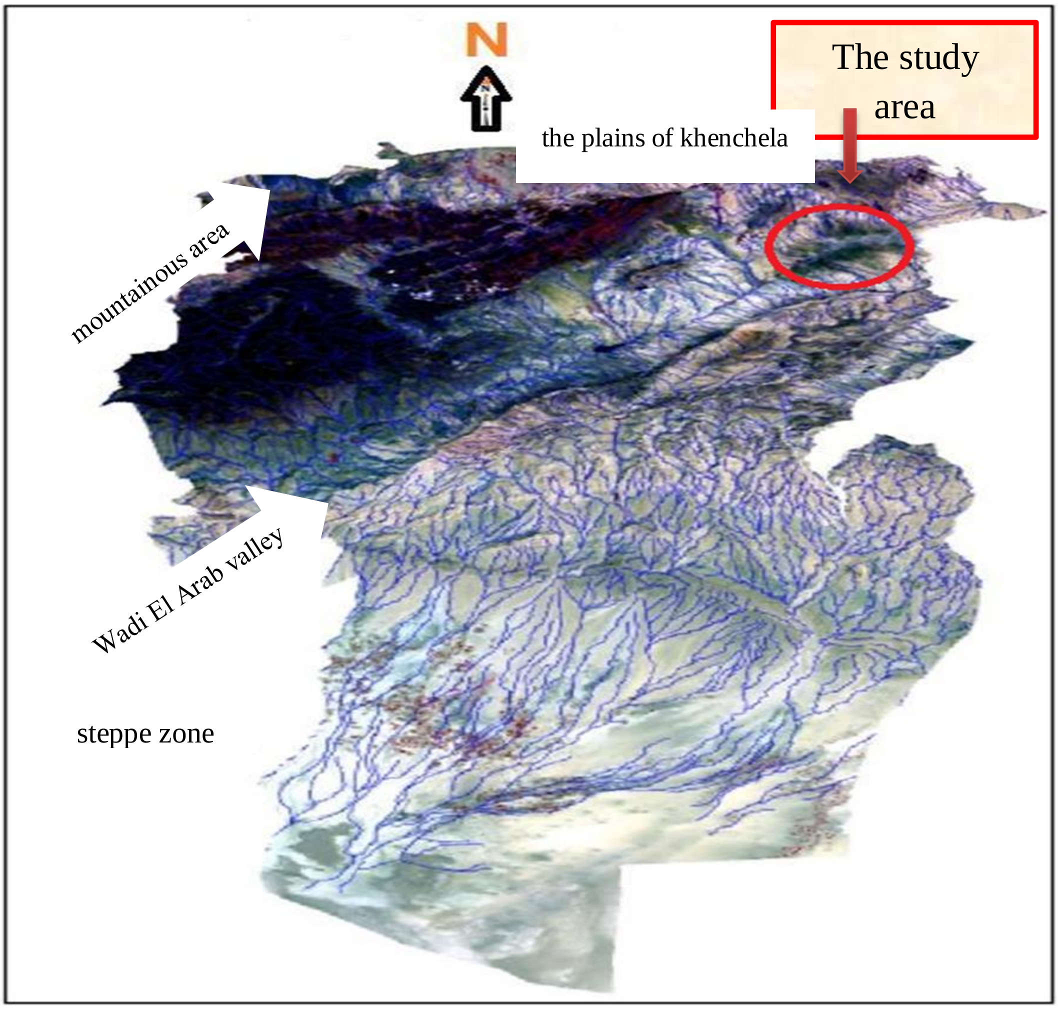


Figure 10: Digital relief model of Khenchela region **(source CENEAP P.A.D.D of the province of Khenchela, 2009).**

1.1.3. Elevation.

The province of Khenchela is characterized by a very steep drop in altitude. Indeed the altitude oscillates between minus 26 meters below sea level (Chott Melghir in the south-east of the province) and 2169 meters above sea level (Djebel Chélia) on the Aurès mountains in the north west of the province.

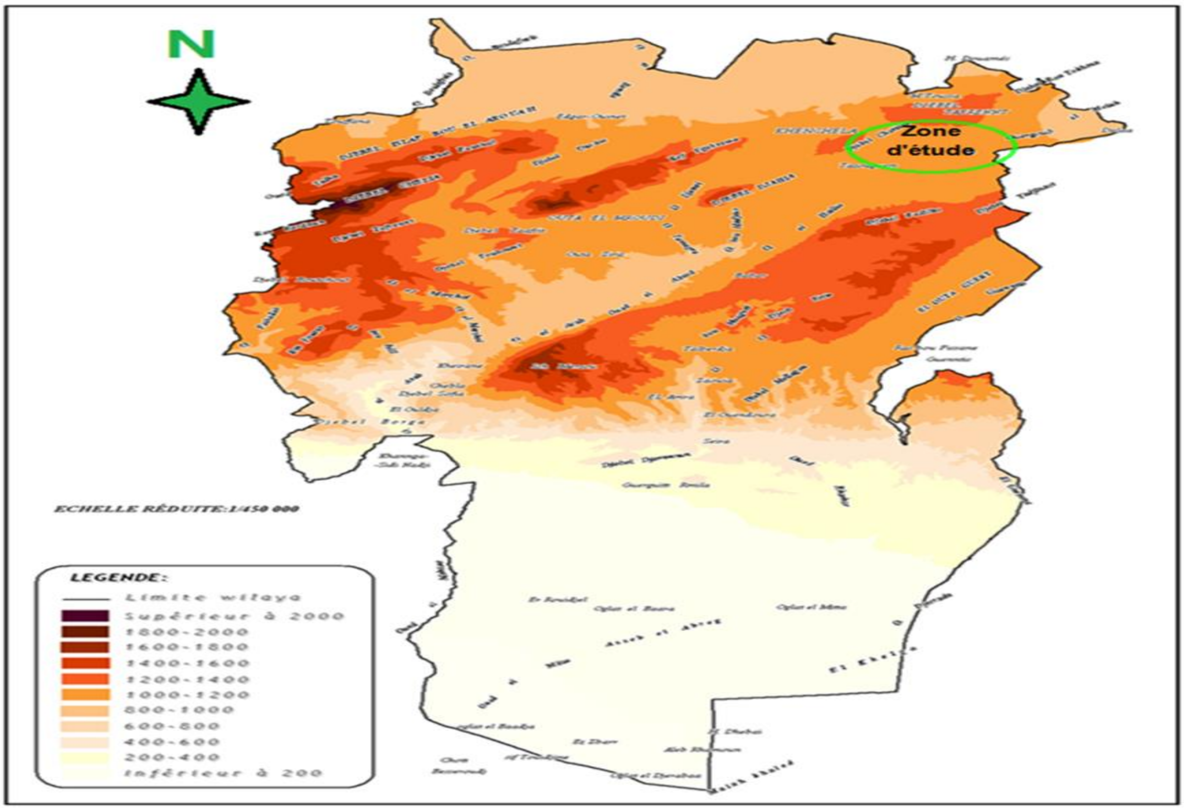


Figure 11: The altitude map of the Khenchela region **(source CENEAP P.A.D.D of the province of Khenchela, 2009)**.

1.1.4. Lithological overview.

Lithologically, the province of Khenchela presents a multitude of facies, the most represented of which are listed below:

- Alluvial deposits and sands.
- Marls.
- Hard limestones and dolomites.
- Friable limestones.
- Triassic (gypsum).

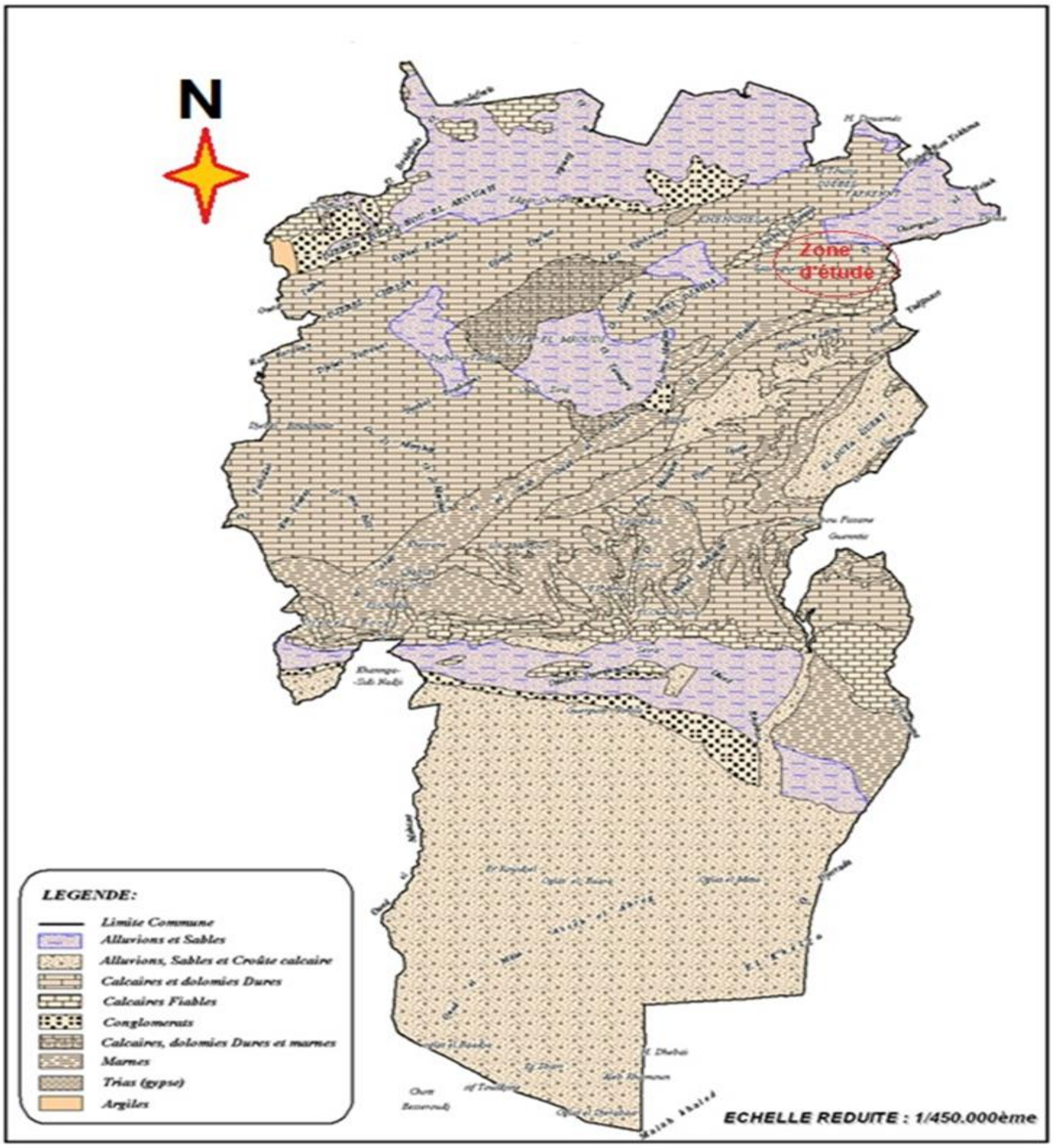


Figure 12: The lithological map of the Khenchela region **(OESRP,2014)**

1.1.4. Soil overview of the main soils of the wilaya.

Given the diverse morphological, lithological, and climatic characteristics of the territory of the province, a wide range of soils is formed, influenced by vegetation cover. The soil map of Algeria, established by JH DURAND and supplemented by more recent localized studies, provides a general overview of the main soil types encountered in the province. According to the soil map produced by DURAND J. H. in 1954 at a scale of 1:500,000, six soil classes were identified, in addition to the class of raw mineral soils (rock outcrops) and halomorphic soils (saline soils) **(OESRP,2014).**

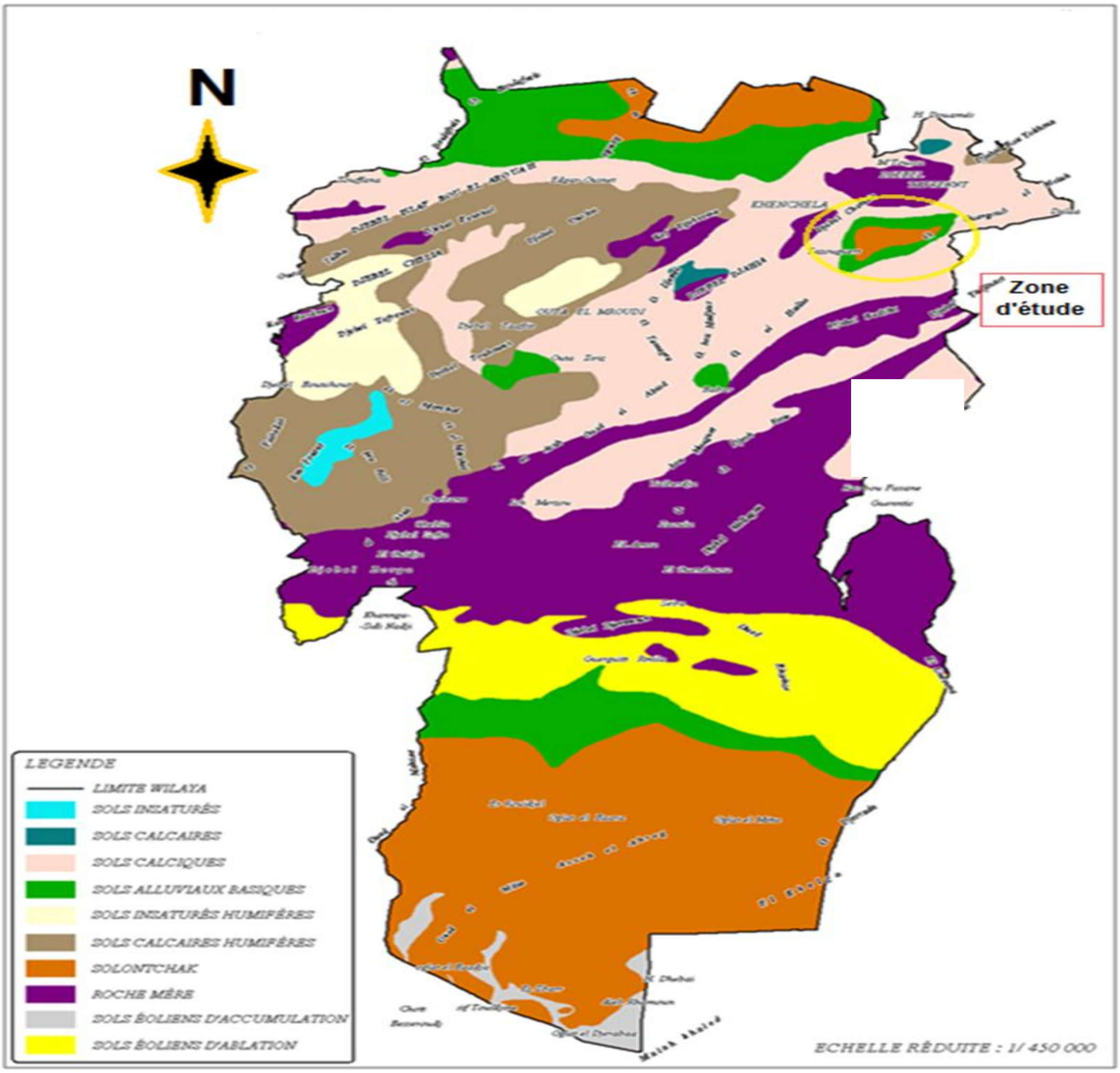


Figure 13: Soil class map of the Khenchela region **(OESRP,2014)**

1.1.5. The climate.

1.1.5.1.Climate.

The province of Khenchela is distinguished by 3 climates:

- a very harsh winter climate, moderate in summer in the central mountain regions.

- a moderate climate in winter, hot and dry in summer in the southern Sahrawi steppes.

-Very cold climate in winter and dry in summer in the high steppes of the north.

This climatic diversity has given the Wilaya a multiple natural inclination giving significant tourist specificities **(Ghedir and Kattoum, 2023).**

1.1.5.2. The temperatures.

- The average of all minimums: - 2 C°
- Average maximum: +21.4 C°
- The absolute maximum observed: +42 C°

The absolute maxima observed during the summer season are very high, which causes a high evaporation during this season **(Ghedir and Kattoum,2023).**

1.1.5.3. The precipitations.

It should be noted that data on precipitation, torrential rain, snow, storms, hail, hoar frost and fog are those of SELTZER; for 25 years observation. Outside the North West mountain region (DJ.Chelia and DJ.Aidel) which receives between 700 and 1200 mm of rain per year and from the south (the Saharan rangelands) which receives less than 200 mm of rain per year (Oued EL Meita) **(Allague et Nedjuo, 2013).**

1.2. Description of Zoui area.

1.2.1. The geographic location.

The municipality of Zoui (Ouled Rechache) is located in the far southeast of the province of Khenchela, bordering the wilaya of Tébéssa (Latitude: 35.2981, Longitude: 7.3531 ,35° 17′ 53″ North, 7° 21′ 11″ East). It falls within the boundaries of the Nememcha mountain range and the Mahmel plateaus. The municipality covers an area of 285 square km, representing 2.93% of the total area of the province. It is situated 24 km east of the capital of the province. Zoui municipality serves as a watershed for water accumulated from the surrounding mountain ranges through temporary tributaries that flow into the negative impact valley of Wadi Zoui on various component **(RMPDRM for the municipality of Zoui ,2018**).

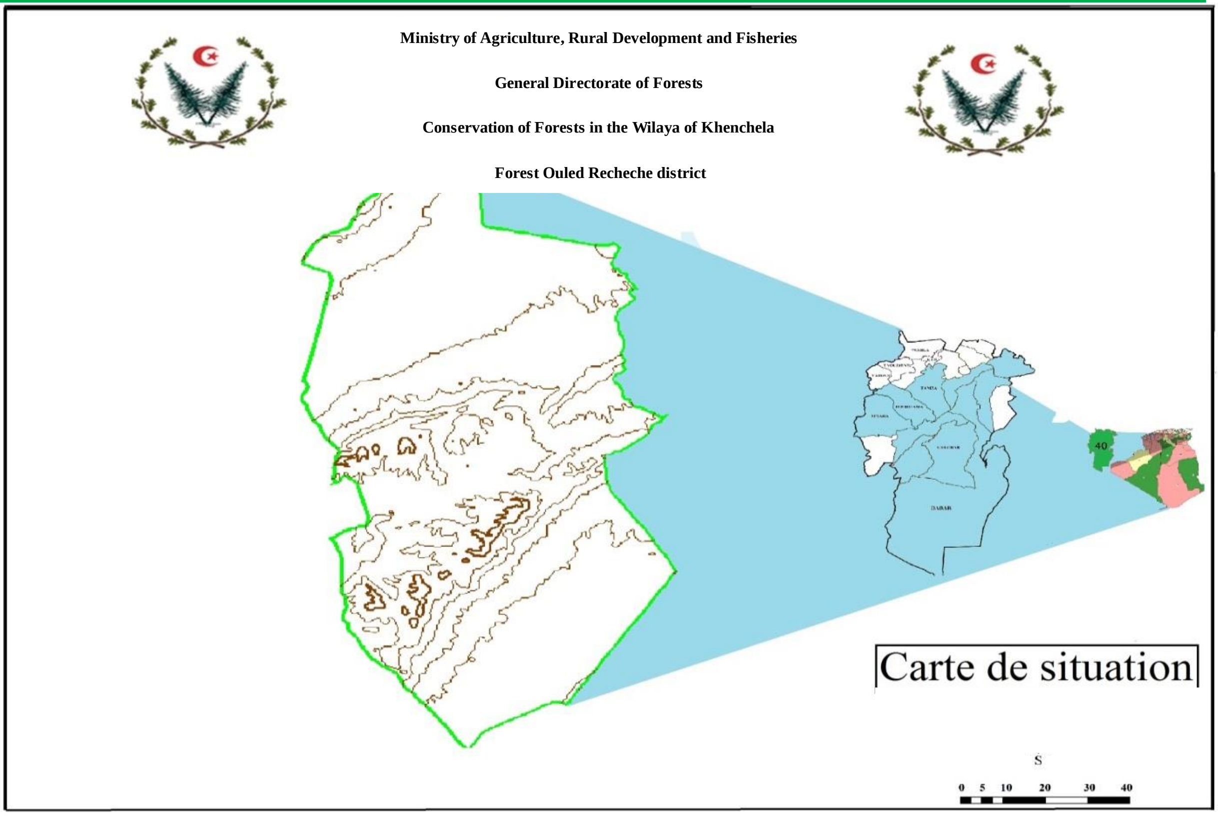


Figure 14: Geographical location of municipality of Zoui **(Forest Zoui district)**

1.2.2. Geomorphology and topography.

Generally, what stands out about the surrounding of the municipality of Ouled Rachache is that lies within two contrasting regions in terms of appearance.

1.2.2.1. The flat area:

Occupying 40% of the total area of the municipality, mostly in the northern and southeastern parts, it is generally bounded by Mount Awina Anssour to the north and the mountains of Jadeeda and ghurab to the south. There are two types of landscapes in this area:

- ❖ **-The foothills area:** with gentle slopes, where the population is concentrated.
- ❖ **-The plains area:** with elevations ranging between 1050m and 1100m, predominantly characterized by agricultural activities.

1.2.2.2. The mountainous region.

Represented by the Jwailia mountain range with a southwest-northeast direction, exemplified by Mount Tadenart with an elevation of 1374 m above sea level, and Mount Awina Anssour with an elevation of 1588m.

1.2.3. Area geology.

Through the geological map, it is inferred that the geological formation of the Ouled Rached area dates back to a sedimentary origin, consisting of deposits from the second and third time periods, and sedimentations from the fourth geological period, as follows:

The second period: Represents the oldest formations belonging to the Jurassic era, composed of shale and limestone.

The fourth period: Particularly prominent in the northern and southern plains of the main cluster, composed of deposits resulting from weathering and erosion factors, consisting of clay, sandy clay, gravel, and glauconite from various formations **(RMPDRM for the municipality of Zoui ,2018**).

1.2.4.Climate and precipitation.

The location of Ouled Rachech in the astern Plateaus and its exposure to the Saharan Atlas mountainous liquid give the plains a dry climate characterized by cold winters and hot ,dry summers,while the rest of the beans represent a transitional stage.

•**Temperature**: Regarding the temperature in the Ouled Rachech region, it varies as we move from north to south, where the highlands are located. The average minimum temperature is -2°C, and the average maximum temperature is +21.4°C. The lowest recorded temperature is -4.8°C, and the highest recorded temperature is +42°C.

•**Precipitation**: The average annual precipitation in the municipality ranges from 200mm to 300mm per year. The recorded amount of rainfall varies from year to year, with significant amounts of ice particularly in spring, with 44.4 days of ice occurrence.

•**Winds**: The Zoui region is exposed to west-northwesterly currents, especially in winter, characterized by dryness and cold. Continental winds, especially the Sirocco winds, also occur in summer, coming from the south and southwest, which are hot and dry, carrying dust and sand **(RMPDRM for the municipality of Zoui ,2018**).

Months	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
Wind speed **m/s**	3,20	3,90	5,10	3,80	3,65	3,68	2,75	2,90	3,20	3,47	3,20	2,89

Figure 15: the wind speed in the state of Khenchela during 12 months of the year 2016

(Meteorological Directorate of Khenchela State)

1.2.5. The hydrographic network.

In the region originates from rivers and surface runoff that penetrate the municipal area from the south through adjacent mountain ranges (Mount Tadjenart and Aouinet Ennser) which are considered the main source of feeding these temporary neighboring rivers towards the north. They represent the source of feeding the underground layers and include any drainage that flows from south to north to reach the depression. Wadi Gantès, which flows towards the south of the municipality **(RMPDRM for the municipality of Zoui ,2018**).

1.2.6. Plant cover.

1.2.6.1 Distribution of forest areas in Zoui.

Forest cover is small in the municipality and does not exceed 17% of the total area .It is found especially in the eastern and south eastern sides **(RMPDRM for the municipality of Zoui ,2018**).The total forest and allied areas at the level of Zoui municipality is about 5,421 hectares, distributed as follows:

	Forest name	**Space**
01	Boureddoussen	96 hectares of Pine
02	M'Zati	360 hectares of Pine
03	Tadlest	297 hectares of Pine
04	Charguia	55 hectares of Pine
05	Tamaroute	441 hectares of Pine +Alfa
06	Lkemiti	855 hectares of Pine + Alfa
07	Laaouidja	685 hectares of Pine + Alfa
08	Ain Fouris-Ain Meslen	948 hectares of Pine + Alfa
09	Aouinetn'sour-Al Zaariria	1684 hectares of Pine + Alfa

Figure 16: Distribution of forest areas in the municipality of Zoui **(Forest Zoui district**).

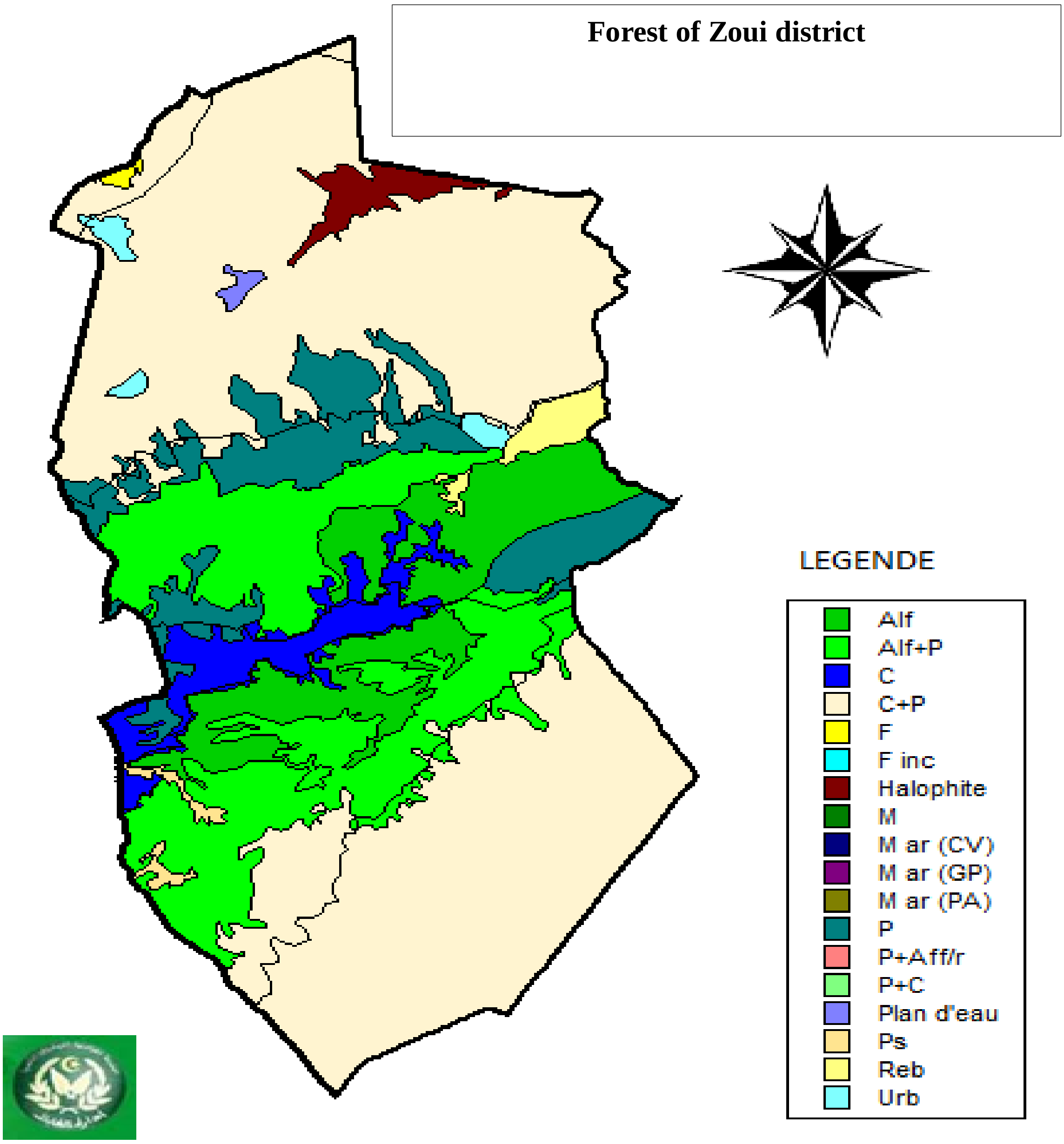


Figure 17: Map of the plants found in the municipality of Zoui (**Forest Zoui district**).

Alf: Alfa / Alf +P: Alfa plus another specific crop or plantation.
C: Annual crop, e.g. cereals, vegetables
C+P: Annual crop combined with planting (fruit trees or other perennial crops).
F: Forest or wooded area.
F inc: Forest including certain particular types of plant cover.
Halophyte: Halophytic plants (Ex: A.annua, Atriplex) / M: Marsh or wetland.
P: Plantation, often permanent crops such as orchards or vineyards
P+Aff/r: Meadow with afforestation or reforestation
P+C: Meadow with crops / Ps: Pastures
Reb: Reforestation (reforested areas)

2. Pollinosis epidemiological survey

In this work, we conducted an epidemiological survey to investigate pollinosis among residents of the city of Zoui. A total of 270 individuals were randomly selected to participate in the survey. The investigation consisted of two main parts:

The first part gathered personal and demographic information from the participants through 4 questions related to age, gender, occupation, and residential area within Zoui. This data allowed us to characterize the study population and identify potential risk factors or patterns associated with specific subgroups.

The second part specifically focused on pollinosis disease and comprised 8 questions. These questions aimed to assess the prevalence, symptoms, and impact of pollen allergies among the surveyed individuals. Participants were asked about their experiences with respiratory issues, seasonal patterns of symptoms, and potential triggers or aggravating factors related to pollen exposure.

The survey questions were designed to capture both single-choice and multiple-choice responses, allowing participants to provide detailed and nuanced information about their condition. All responses were carefully collected and recorded to determine the extent of the impact of pollen allergies and understand how pollen is transported within the municipality of Zoui.

The data obtained from this epidemiological survey was processed and analysed using Sphinx software, a specialized tool for handling and interpreting survey data. This analysis enabled us to identify patterns, correlations, and potential risk factors associated with pollinosis in the study area.

Fiche d'enquête sur les allergies au pollen N° Fiche.....

Informateur :.........................

1.Age : □ ≤15 ans, □15-20 ans, □20-30 ans, □30-40 ans

□40-50 ans, □50-60 ans, □≥ 60ans

2. Sexe : □Masculin, □Féminin

3. Lien de vie : □Zone urbaine, □Zone rurale

4.Temps passé à l'extérieur par jour : □2h, □4h, □6h, □8h.

Questionnaire

1. Avez-vous une allergie ? □Oui, □Non

2. A quoi êtes-vous allergique ? □ Plantes, □Aliments Produits chimique □Poussière, □Animaux, □ Je ne sais pas.

3. Comment se manifeste votre allergie ?

□Rhune, □Toux, □Asthme, □Cutanée (urticaire, eczéma), □ Irritation des yeux, □Autre............................

4. Votre allergie se manifeste-elle ?

□Toute l'année, □L'automne, □L'hiver, □ Printemps, □ L'été.

5. Avez-vous des personnes allergiques dans votre famille ? □ Oui, □Non

6. Avez-vous Consulté un médecin pour votre allergie ? □Oui, □Non

□Médecin généraliste, □ Un allergologue

7. Continuez-vous le suivi médicale de votre allergique ? □Oui, □Non

8. Avez-vous observé de l'amélioration? □Oui, □Non

Figure 18: The formula of our survey.

1.Results

1.1 Survey Results

An allergological study was conducted in the city of Zoui to assess the prevalence of pollinosis. The primary objective of the survey was to determine the proportion of individuals affected by this condition within the studied population. Due to the transient nature of pollinosis symptoms, ascertaining the precise incidence rate is impractical. Consequently, the study focused on observing the prevalent cases within a representative sample of the population. The study employed a probabilistic or simple random sampling methodology to ensure an unbiased selection process. A total of 270 individuals were recruited to participate in the survey. The collected data were meticulously analyzed using Sphinx software, a specialized statistical tool designed for the comprehensive evaluation of survey data.

1.1.1. Population distribution by Age and Gender

Figures 19 and 20 present the data and analysis on the total number and composition by age and gender of the 270 individuals who participated and agreed to answer the questions in our survey. The largest age group represented in the survey is the 20-30 years old category, comprising 28.1% of the participants. This is followed closely by the 30-40 years old age group, which accounts for 22.6% of the respondents.The third-largest group is individuals aged 15 years or younger, making up 15.6% of the sample. The age groups of 40-50 years and 50-60 years constitute 11.1% and 9.6% of the participants, respectively. The smallest age group is those 60 years or older 7% .

Age

	Nb	% obs.
Less than or equal to 15 years old	**42**	**15,6%**
15-20	**16**	**5,9%**
20-30	**76**	**28,1%**
30-40	**61**	**22,6%**
40-50	**30**	**11,1%**
50-60	**26**	**9,6%**
Greater than or equal to 60 years old	**19**	**7,0%**
Total	**270**	**100,0%**

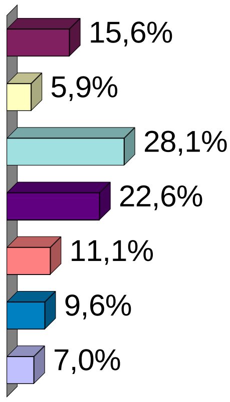


Figure 19: The age distribution of the 270 participants in the survey

Gender

	Nb	% obs.
Male	**109**	**40,4%**
Feminine	**161**	**59,6%**
Total	**270**	**100,0%**

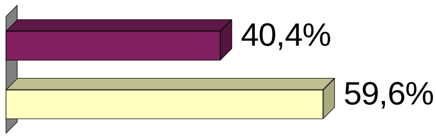


Figure 20: The gender distribution of the 270 participants in the survey

1.1.2. Place of living.

The figure 21 presents the distribution of the survey participants based on their place of living, categorized as urban area, rural area, or a combination of both urban and rural areas.

The majority of the participants, 74.1% (200 individuals), reside in urban areas. This suggests a significant representation of city dwellers or those living in more densely populated regions within the surveyed population.

A smaller proportion, 12.6% (34 individuals), live in rural areas, which likely encompasses smaller towns, villages, or countryside regions within the study area.

The remaining 13.3% (36 individuals) reported living in both urban and rural areas, indicating a potential commute between these two settings or residing in areas that encompass characteristics of both urban and rural environments.

Place of living

	Nb	% cit.
Urban area	**200**	**74,1%**
Rural area	**34**	**12,6%**
Urban and Rural area	**36**	**13,3%**
Total	**270**	**100,0%**

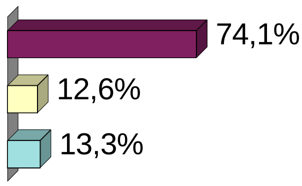


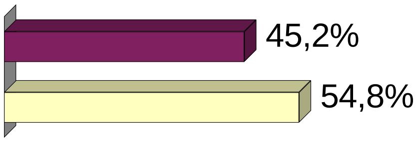
Figure 21: Population distribution by place of living

1.1.3 Prevalence of allergies.

According to the figure 22 which represents the prevalence of allergies, we find that 45.2% of the 270 participants experience allergy symptoms at least once a year, and 54% of them do not suffer from allergies .

Do you have an allergy?

	Nb	% obs.
Yes	**122**	**45,2%**
No	**148**	**54,8%**
Total	**270**	**100,0%**



.

Figure 22: Prevalence of allergies

1.1.4 Time spent outside per day.

Figure 23 displays the percentage of participants staying outside the home, and we found that the most participants spend 8 hours outside the home,at a rate of 61.1% out of 270 participants ,and an average of 24.1% they spend 2 hours outside the home every day.

Time (h) spent outside per day

	Nb	% obs.
2h	**65**	**24,1%**
4h	**16**	**5,9%**
6h	**24**	**8,9%**
8h	**165**	**61,1%**
Total	**270**	**100,0%**

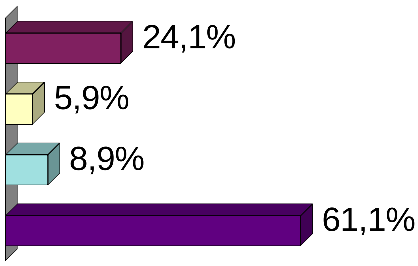


Figure 23: Time spent outside per day.

1.1.5 Causes of allergies.

According to the subjects of our survey, dust was the main cause of allergy with 38.7% of the total reponses, then allergies due to chemicals and plants with 27.6% and 16% respectively.

What are you allergic to?

	Nb	% cit.
Plants	**29**	**16,0%**
Chemicals	**50**	**27,6%**
Dust	**70**	**38,7%**
Animals (hair, feathers...)	**18**	**9,9%**
I don't know	**14**	**7,7%**
Total	**181**	**100,0%**

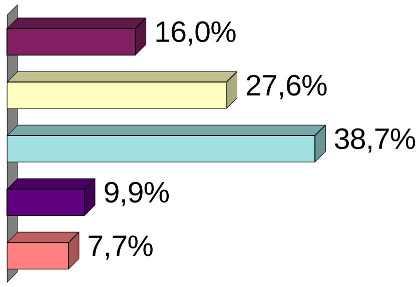


Figure 24: Causes of allergies.

1.1.6 Symptômes of allergy.

The columns represents the percentages of symptoms of allergy , the analysis of reponses regarding symptoms showed a predominance of nasal congestion (23.8%) and eye irritation (23.4%) , followed by skin reactions and cough (20.7%) and asthma (14.2%), with other symptoms ranking last at (1.1%).

How does your allergy manifest?

	Nb	% cit.
Rhune	**62**	**23,8%**
Cough	**54**	**20,7%**
Asthma	**27**	**10,3%**
Skin (urticaria, eczema)	**54**	**20,7%**
Irritation of eyes	**61**	**23,4%**
Other.....	**3**	**1,1%**
Total	**261**	**100,0%**

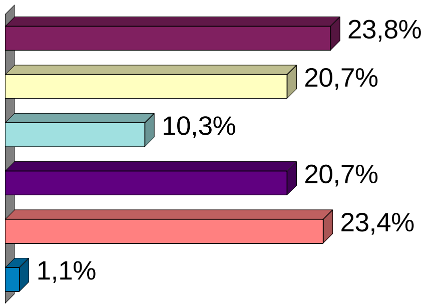


Figure 25: Symptoms of allergy

1.1.7 Period showing of allergy symptoms

These figure represent duration of allergy at 270 participants , the result of our survey that indicates a predominance of individuals suffering from allergies all year round at 84.7%, followed by 11.3% in spring, 2.4% in summer , and finally, 0.8% in autumn and winter.

Is your allergy showing ?

	Nb	% cit.
All year round	**105**	**84,7%**
Autumn	**1**	**0,8%**
Winter	**1**	**0,8%**
Spring	**14**	**11,3%**
Summer	**3**	**2,4%**
Total	**124**	**100,0%**

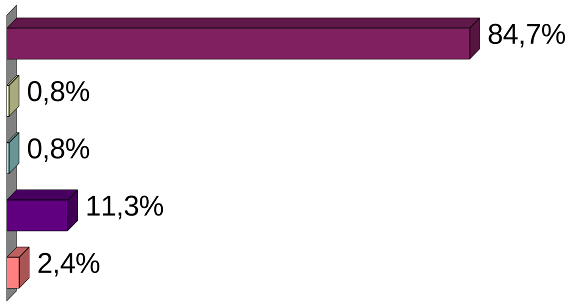


Figure 26: Duration of allergy

1.1.8 Specialty of the doctor consulted.

The document represent the difference in percentages based on the specialty of doctors consulted, according to our analysis we found 33.3% of patients consulted general practitioners, and 66.7% consulted allergology specialists.

What is the doctor's specialty?

	Nb	% cit.
General practitioner	**28**	**33,3%**
Allergist	**56**	**66,7%**
Total	**84**	**100,0%**

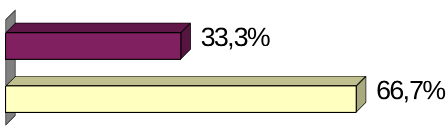


Figure 27: Specialty of the doctor consulted

1.1.9.Medical consultation.

The figure 28 is for medical consultation, according to our survey, and according to the results obtained: 68.9% of patients consulted a doctor, however 31.1% said no.

Have you consulted a doctor about your allergy?

	Nb	% cit.
Yes	**84**	**68,9%**
No	**38**	**31,1%**
Total	**122**	**100,0%**

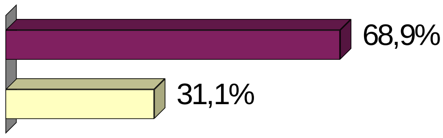


Figure 28: Medical consultation

1.1.10 Medical follow-up.

This figure shows that 84.5% of the participants complete their treatment, and 15.5 %of them do not complete it.

Do you continue medical monitoring of your allergy ?

	Nb	% cit.
Yes	**71**	**84,5%**
No	**13**	**15,5%**
Total	**84**	**100,0%**

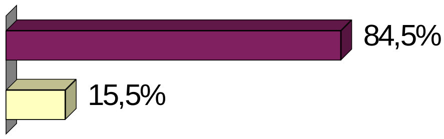


Figure 29: Medical follow-up

1.1.11 Improvement after medical follow-up.

The document is for the percentage of improvement of patients after continuing treatment we found 89.3% of allergic people observe a clear improvement after medical follow-up and 10.7% answered no.

Have you observed an improvement ?

	Nb	% cit.
Yes	**75**	**89,3%**
No	**9**	**10,7%**
Total	**84**	**100,0%**

Figure 30: Amelioration after medical follow-up

1.1.12 Presence of allergy in the family.

In these figures we notice that 80.3% of participants in the study have at less one allergic person in their family and 19.7% they don’t have anyone in the family who has allergies.

Do you have anyone with allergies in your family?

	Nb	% cit.
Yes	**98**	**80,3%**
No	**24**	**19,7%**
Total	**122**	**100,0%**

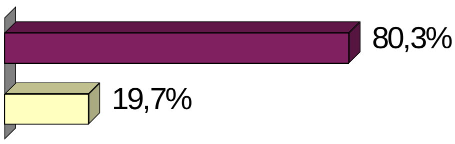


Figure 31: Presence of allergy in family

1.1.13 Prevalence of allergy according to age groups

Figure 32 represents the number of people with an allergy in relation to the age groups, the results obtained indicate that all age groups can be affected by the allergy. However, peoples aged between 40-50 and 50-60 seem the most sensitive and the ages 15-20 are less likely to suffer from allergies.

Prevalence of allergy according to age group

	Less than or equal to 15 years old	15-20	20-30	30-40	40-50	50-60	Greater than or equal to 60 years old	**Total**
Yes	**45,2%**	**25,0%**	**43,4%**	**44,3%**	**60,0%**	**50,0%**	**42,1%**	**45,2%**
No	**54,8%**	**75,0%**	**56,6%**	**55,7%**	**40,0%**	**50,0%**	**57,9%**	**54,8%**
Total	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**

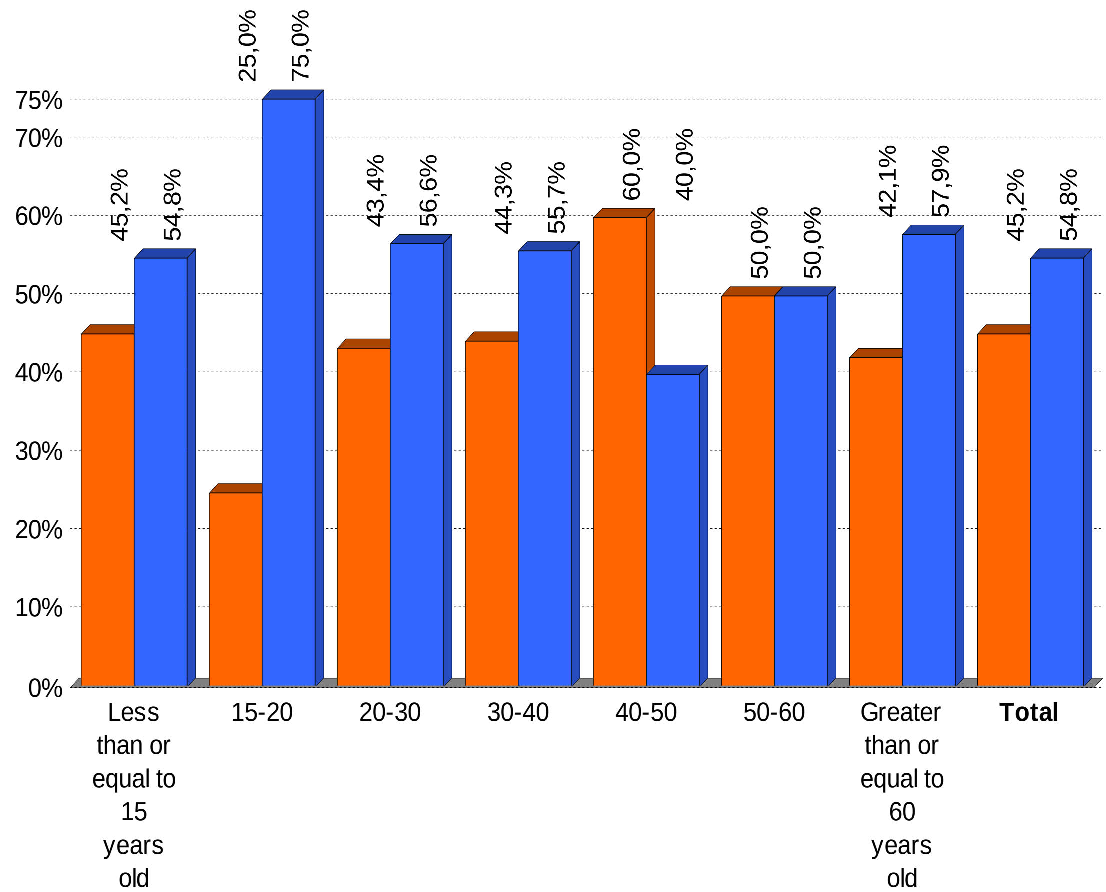


Figure 32: Prevalence of allergy according to age groups

1.1.14 Causes of allergy by age group

The figure 33 for the causes of allergies by age group, where we noticed the chemical products and dust are the main causes of allergies for all age groups. However, the age groups 15-20, 30-40, and 50-60 years are the most sensitive to the latter.

Causes of allergies by age group

	Less than or equal to 15 years old	15-20	20-30	30-40	40-50	50-60	Greater than or equal to 60 years old	Total
Plants	17,2%	0,0%	31,0%	17,2%	17,2%	13,8%	3,4%	100,0%
Chemicals	18,0%	2,0%	28,0%	26,0%	12,0%	8,0%	6,0%	100,0%
Dust	9,9%	5,6%	28,2%	23,9%	15,5%	12,7%	4,2%	100,0%
Animals (hair, feathers...)	22,2%	5,6%	38,9%	11,1%	11,1%	11,1%	0,0%	100,0%
I don't know	14,3%	0,0%	0,0%	28,6%	28,6%	14,3%	14,3%	100,0%

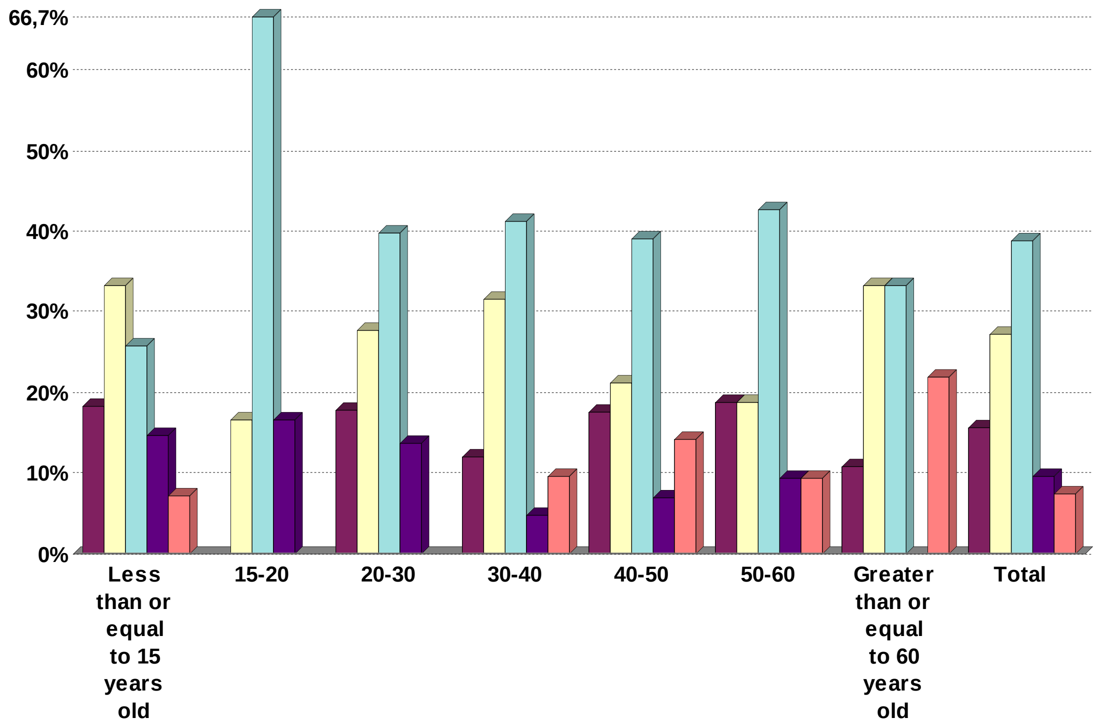


Figure 33: Causes of allergy by age group

1.1.15 Prevalence of allergy by gender

Figure 34 the figure represents the number of people with an allergy in relation to their gender, the results obtained indicate that 56.9% of the men subject to our survey have an allergy compared to 53.4% of women

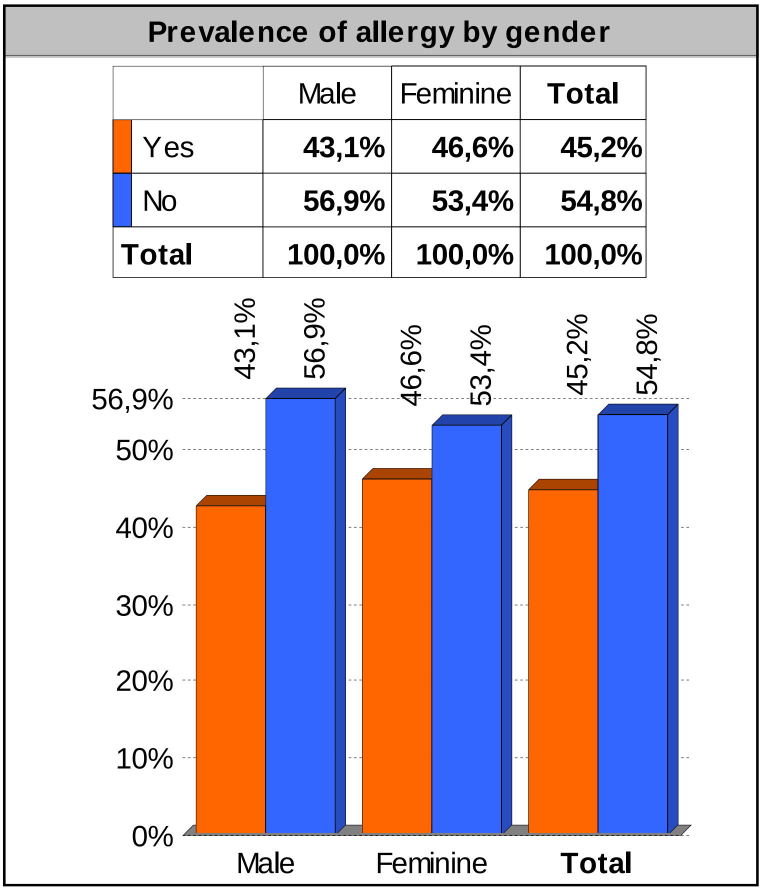


Figure 34: Prevalence of allergy by gender

1.1.16 Prevalence of allergy by place living

According to figure 35 which represents the number of people with an allergy in relation to their place of life, the results indicate that 52.8% with allergies live in urban and rural areas, whereas 46% live in urban areas and 32.4 % live in rural areas.

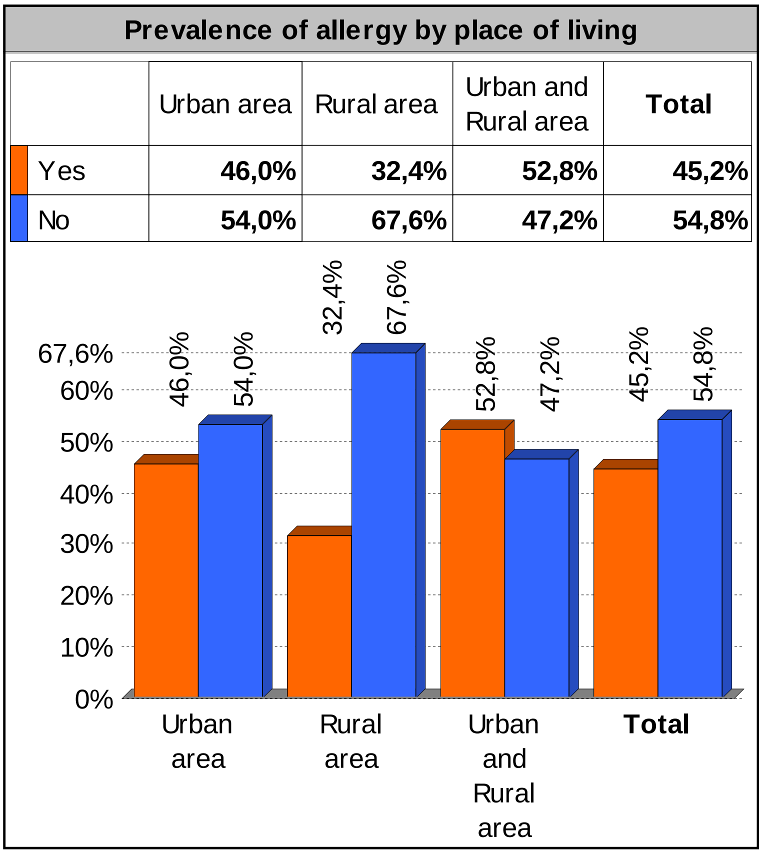


Figure 35: Prevalence of allergy by place living

1.1.17 Allergy prevalence and time spent outside per day .

The figure 36 represent prevalence of allergy and time spent outside per day, we found that people who spend 6 hours outside the home are the most susceptible to allergy, and people who spend 8 and 4 hours are the least affected.

Allergy prevalence and time spent outside per day

	2h	4h	6h	8h	**Total**
Yes	**46,2%**	**43,8%**	**54,2%**	**43,6%**	**45,2%**
No	**53,8%**	**56,3%**	**45,8%**	**56,4%**	**54,8%**

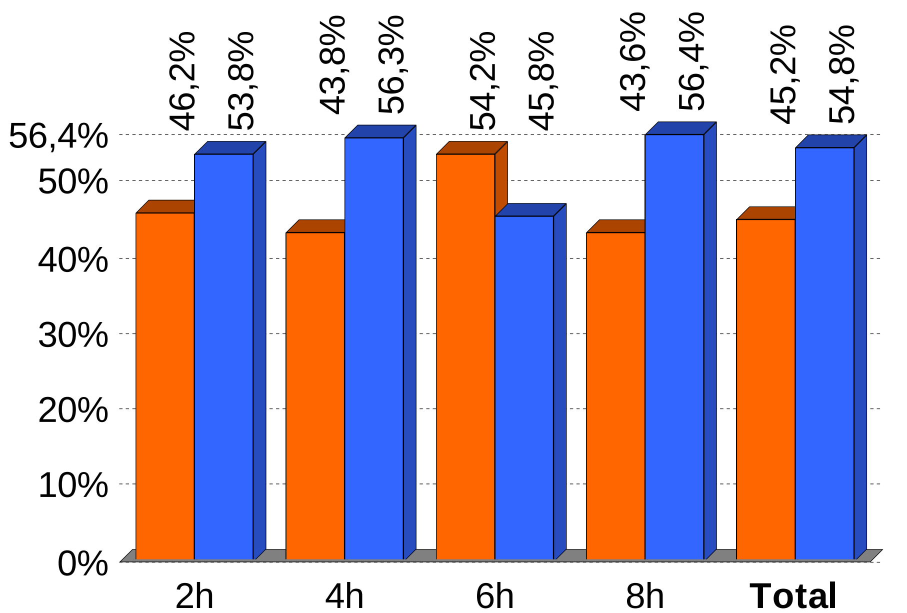


Figure 36: Allergy prevalence and time spent outside per day

1.2. Wind direction study

1.2.1 Wind direction in autumn season

Based on the diagram, the predominant wind direction seems to be from the northwest (NW), This suggests that winds from the Nothwestern direction are the most common at this location in the autum seaseans. The second most frequent wind direction appears to be from the southwest (SW).

The west (W) directions, also show notable wind frequencies, although lower than the NW and the SW directions.

The shorter bars for the north (N), east (E), southeast (SE), and south (S) directions indicate that winds blowing from these directions are relatively less frequent at this location.

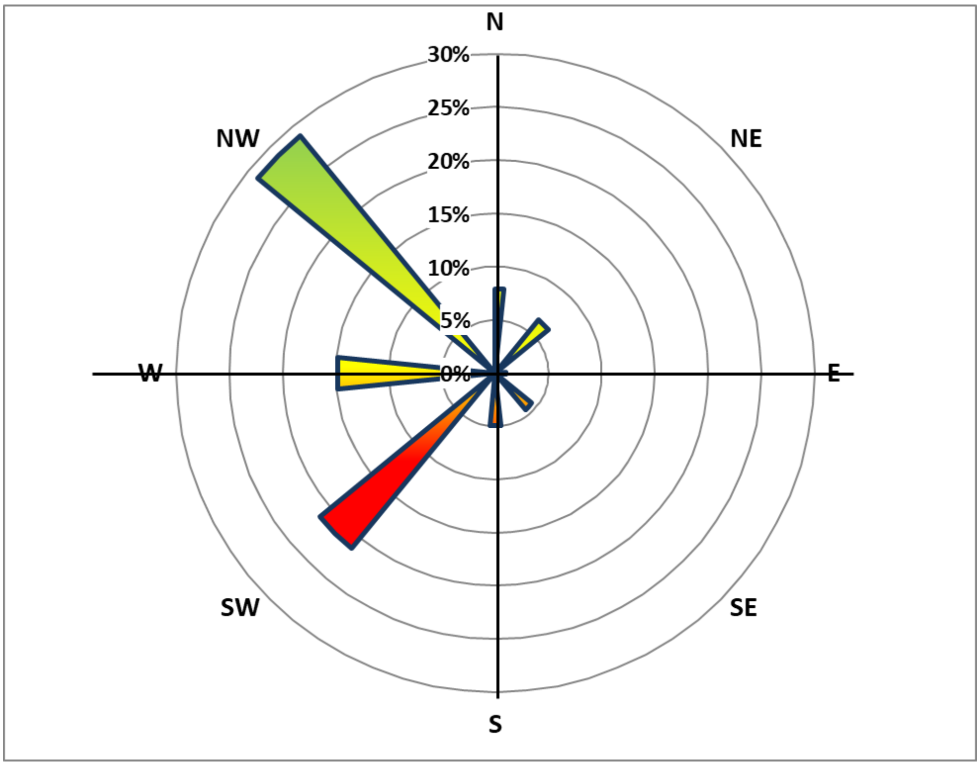


Figure 37: Wind direction in autumn season

1.2.2 Wind direction in spring season

Based on the wind rose diagram, the predominant wind directions in spring season, that could potentially transport pollen into the study area seem to be from the northwest (NW) and southwest (SW). The north Est, also appear to have a considerable frequency, suggesting that pollen could be carried into the area from those directions as well, albeit to a lesser extent compared to the western and southwestern winds. The northern (N), eastern (E), southeastern (SE), and southern (S) directions indicate that winds from these directions are relatively less frequent and may contribute less to pollen transport into the study area.

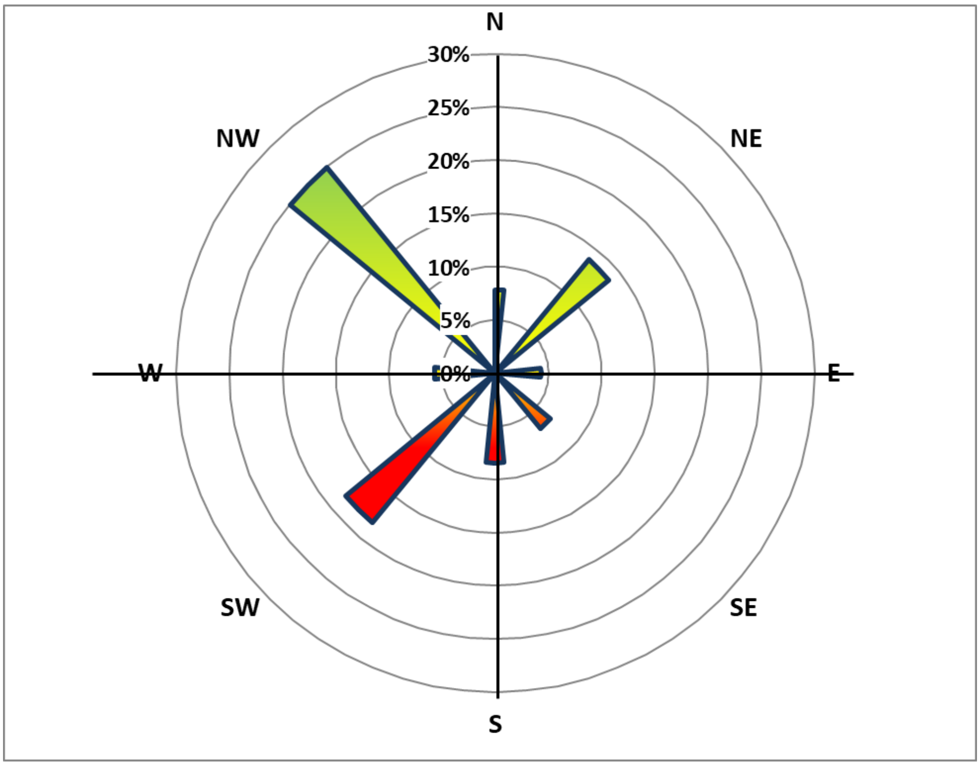


Figure 38: Wind direction in spring season

1.2.3 Wind direction in winter season

The wind rose diagram indicates that during winter, the NW winds are the most dominant and strongest, which means they play a significant role in the movement of pollen. Pollen from sources to the NW will likely be dispersed over larger distances and in greater quantities towards the SE.

The North-West (NW) is the most frequent wind direction, with the highest frequency reaching up to 20%. West (W) is another significant direction, with notable wind frequencies around 10-15%.

South-West (SW), South (S), South-East (SE), East (E), North-East (NE), and North (N), These directions show relatively lower frequencies, with the highest being around 10% or less. Pollen from plants located to the NW of a given point is likely to be dispersed over longer distances due to the strong and frequent winds from this direction.

Areas to the SE of the NW plant sources may receive higher concentrations of pollen, impacting the distribution and potential for pollination in these areas.

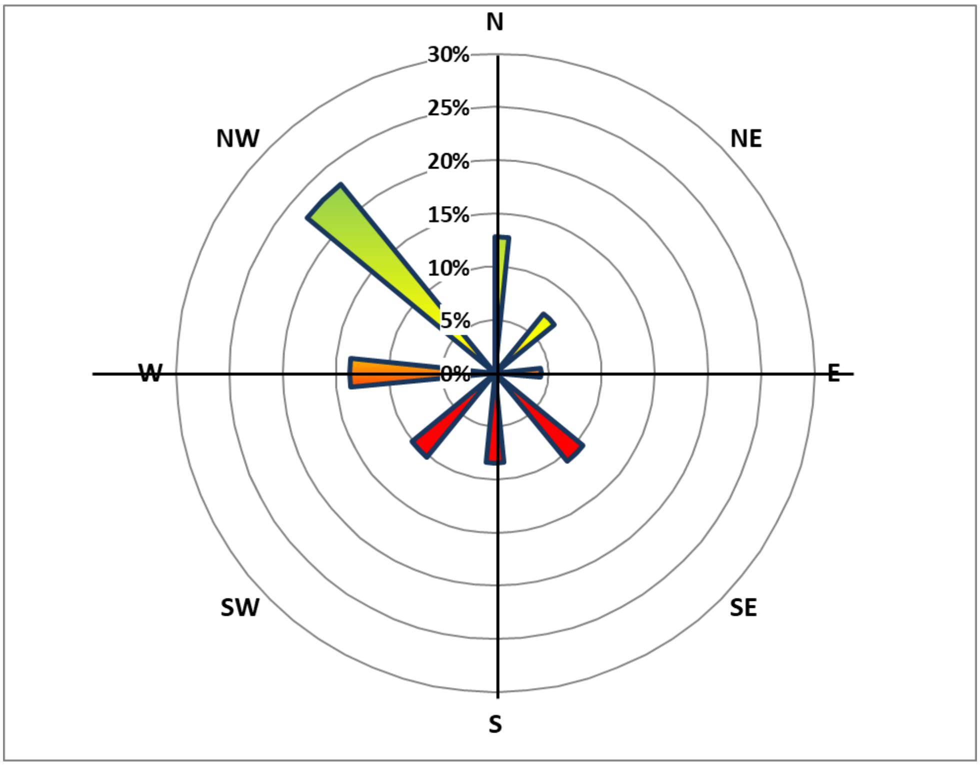


Figure 39: Wind direction in winter season

1.2.4. Wind direction in winter summer

The wind rose diagram indicates that during summer, the NW winds are the most dominant, which means they play a significant role in the movement of pollen. Pollen from sources to the NW will likely be dispersed over larger distances and in greater quantities towards the SE.

North-West (NW) is the most frequent wind direction, with wind occurring up to 23% of the time. This indicates that NW winds dominate during the summer season.

The North (N) and the North-Est (NE) are also common, with frequencies ranging from 10% to 15%. This makes another significant wind direction during this period.

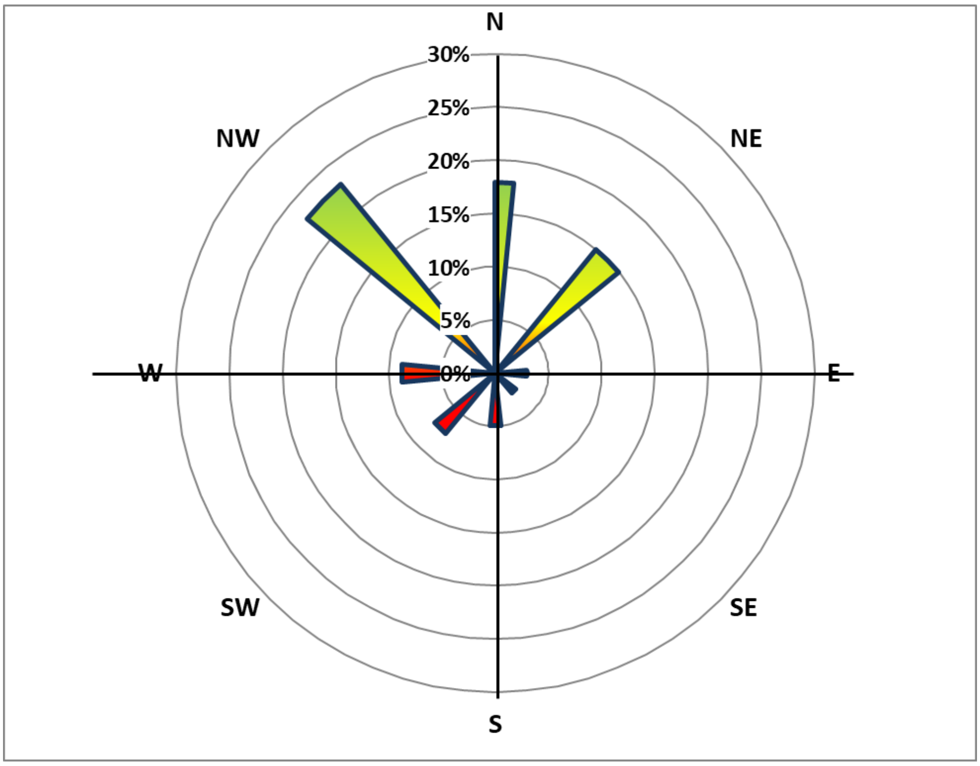


Figure 40: Wind direction in summer season

1.3. Zoui's Peripheral Landscapes

In a diameter from 01 to 10 Km around the Zoui urban area, the vegetation cover includes *Pinus halepensis* forests, *Quercus suber*, and a few isolated trees of the Atlas cedar. There are also very large expanses of cultivated fields with wheat and other cereals, such as barley, a large areas that contain halophytic weeds and semi-arid zone plants. We can also find fruit trees like apples, pears, and olives. According to khenchela forest direction (district of Zoui). The zoui region we can find:

- **Maquis species:** Myrtus (Myrtle), Rosmarinus (Rosemary), Juniperus (Juniper).

- **Scrubland species:** Thymus (Thyme), Lavandula (Lavender), Quercus coccifera (Kermes oak).

-**Halophytic species:** Salicornia (Glasswort), Salsola (Saltwort). Annual artemisia, Cladium mariscus.

-**Riparian vegetation:** Alnus (Alders), Salix (Willows), Populus (Poplars).

-**Agricultural crops:** cereal crops.

In a diameter of 0.5 to 1 km around the urban area of Zoui, the vegetation cover is different from the region from 1 to 10 km. The area has more ornamental plants and some fruit plants (figure xxx). The figure of the distribution of vegetation in the city centre within a radius of 500 meters from the Zoui district shows empty areas populated by large quantities of small grasses such as *Elytrigia repens*, the most well-known grass weed, as well as *Oxalis corniculata, Plantago lanceolata, Brachiaria eruciformis, and Polypogon monspeliensis.*

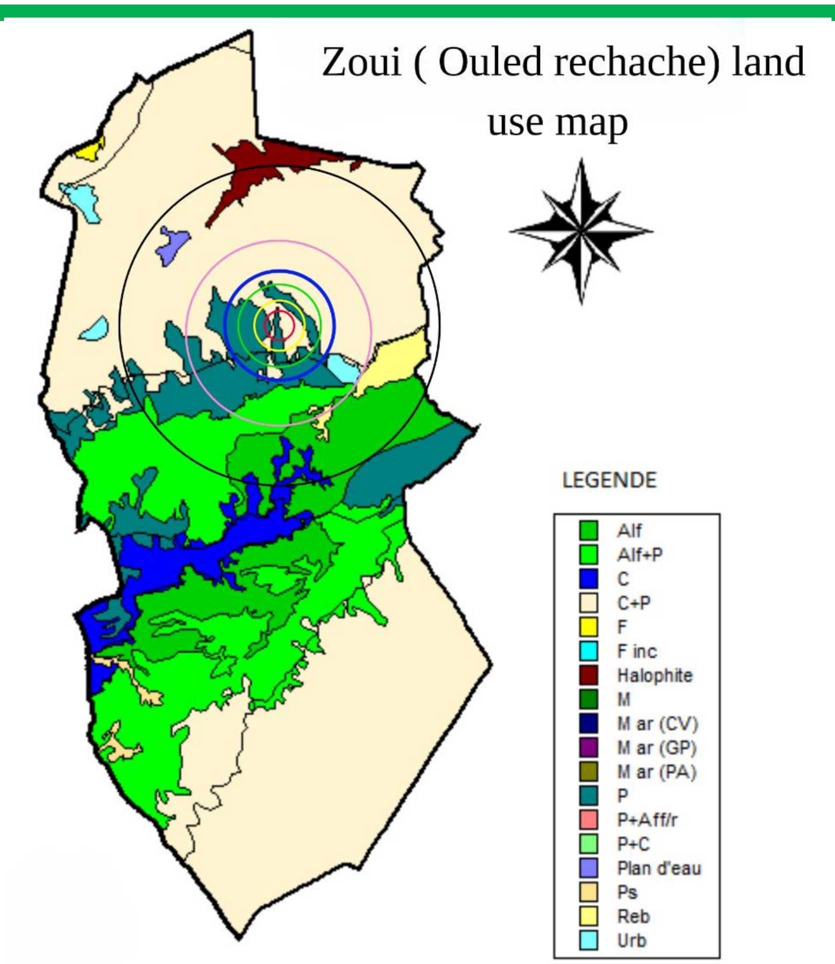


Figure 41 : Zoui (Ouled rechache) land use map

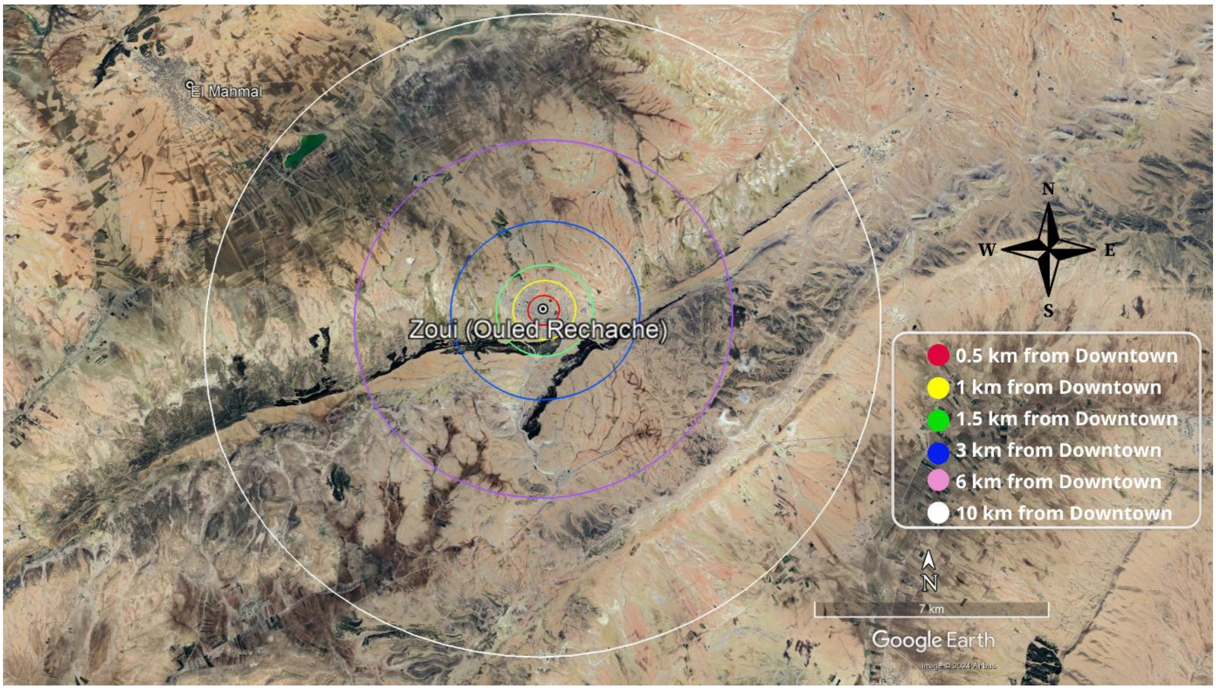


Figure 42 : The surroundings around 10 km from the town center of Zoui

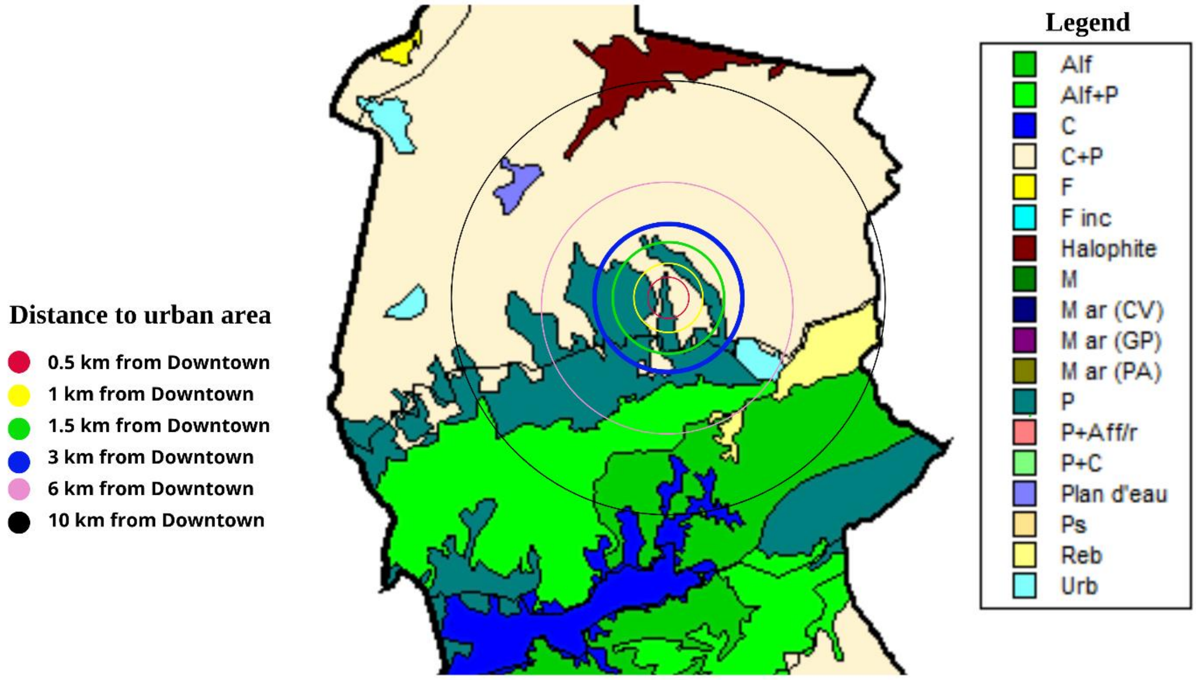


Figure 43 : Zoui (Ouled rechache) land use map at 10 Km

Figure 44 : The surroundings around 3 km from the town center of Zoui

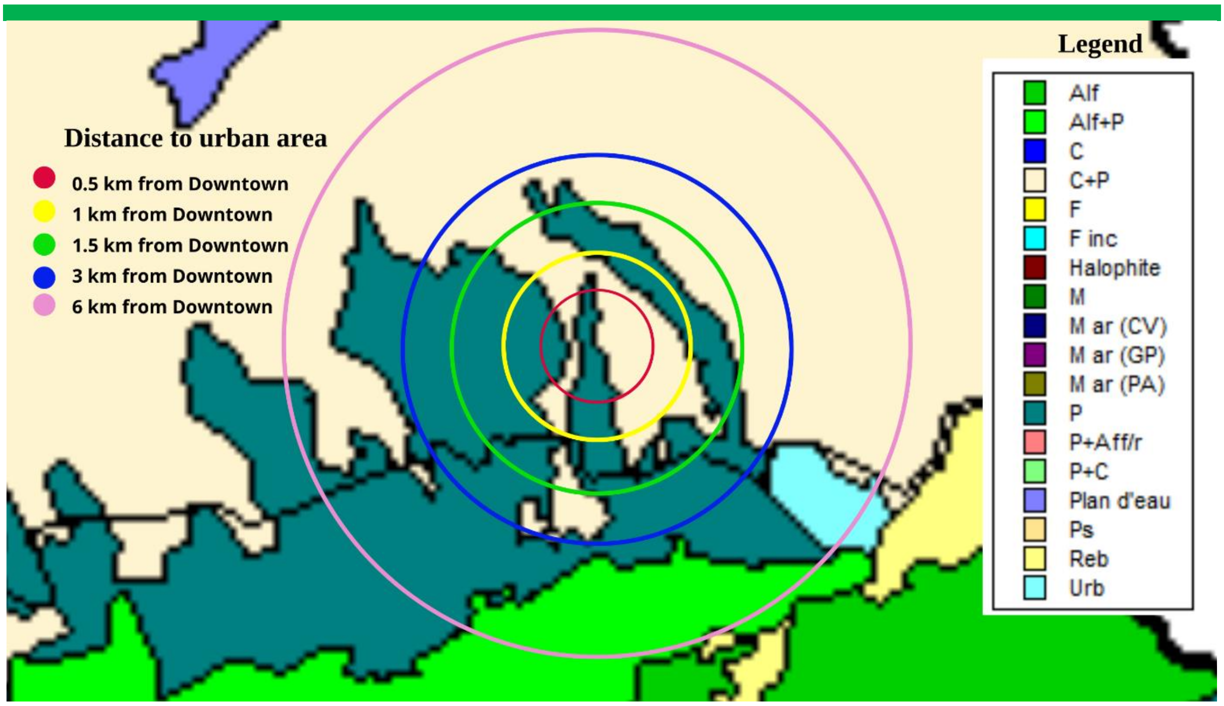


Figure 45 : Zoui (Ouled rechache) land use map at 6 Km

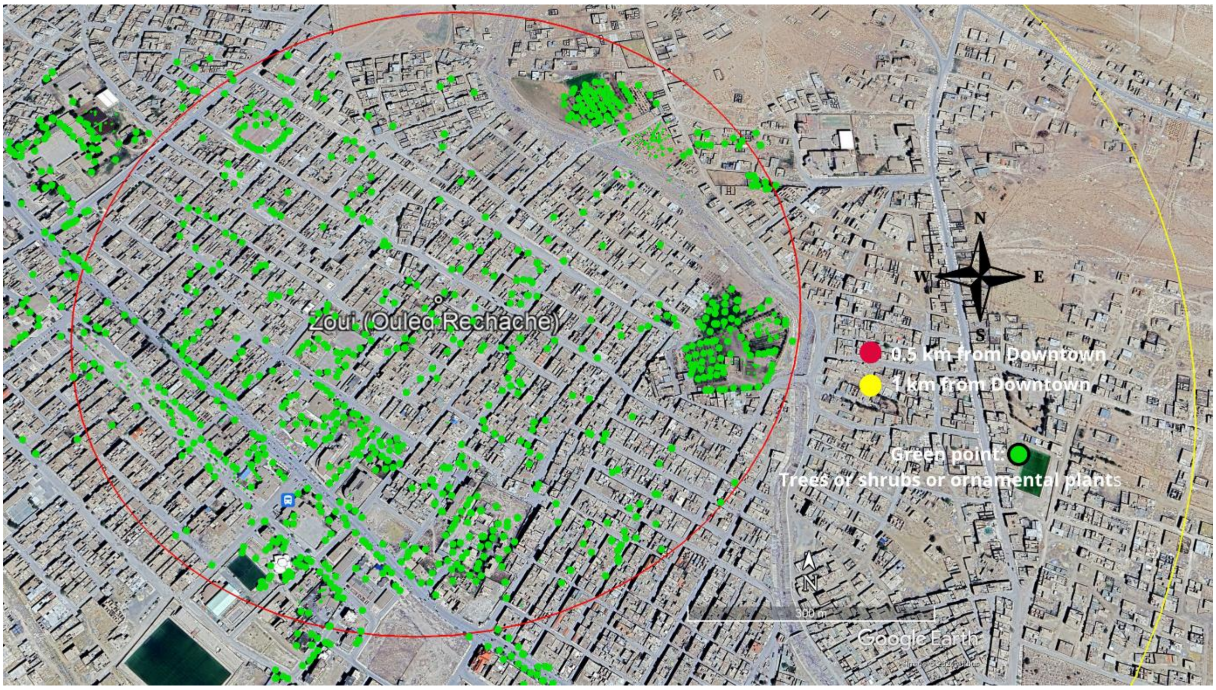
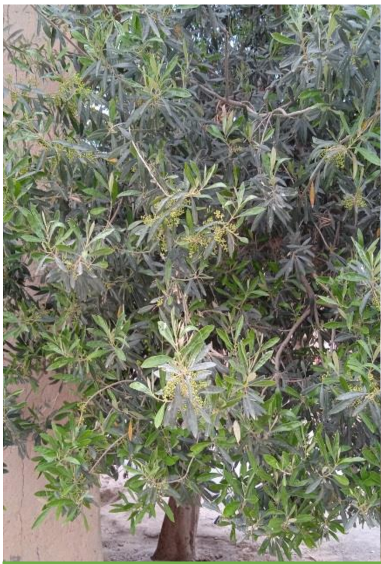


Figure 46: Distribution of vegetation in the city center within 500 meters of the Zoui district.

Figure 47. Some types of plants identified in 0.5 and 1 Km from Downtown



Olea europaea

Chênes-lièges

Pines

Platanus orientalis

Washingtonia robusta

Moraceae

Ficus carica

Eriobotrya japonica

Vitis vinifera

Prunus armeniaca

Cydonia oblonga

Nerium oleander

2. Discussion

In this study, the discussion is primarily directed towards collecting demographic and health data by conducting an epidemiological survey in the urban area of Zouï (Ouled Rechache, Khenchela), Also the impact of local plant species in the Zouï region on the occurrence of pollinosis through a survey conducted on 270 individuals living in the Zouï area. By conducting an epidemiological survey that considers wind direction and vegetation, we can gain comprehensive insights into the complex interplay of environmental factors contributing to pollinosis.

In our study, a random survey was used because it helps ensure that the sample is representative of the entire population, reducing bias and increasing the generalizability of the results. Because we had some citizens of Zouï city who did not accept to participate in our epidemiological survey, the distribution was not equal in terms of gender and age. The survey revealed that the majority of participants were young adults aged 20-30 years (28.1%), followed by those aged 30-40 years (22.6%). This suggests that younger adults are more likely to participate in health-related surveys, possibly due to higher awareness and use of digital platforms. The smallest group was the 60 years or older category (7%), likely due to reduced engagement or lower exposure to pollen resulting from less outdoor activity.

Men (56.9%) had a slightly higher allergy prevalence compared to women (53.4%). Gender differences in allergic responses might be due to hormonal influences and occupational exposures. **Zielhuis et al. (1990)**, found similar gender differences in allergy prevalence, influenced by occupational and environmental factors.

Our results show that a significant majority (74.1%) of participants live in urban areas, with fewer from rural (12.6%) and combined environments (13.3%). Nearly half (45.2%) of participants reported experiencing allergy symptoms at least once a year. This high prevalence could be attributed to the diverse allergenic causes in the area, such as pollen of Olea europaea and Pines, as well as pollution. The transient nature of pollinosis complicates precise incidence measurement. According to **Krämer et al. (2000),** there is a positive relation between urban areas and air diseases, whereas sensitization is high in the suburban. Urbanization, a major force driving changes in neighbourhood environments, may affect residents' health by influencing their daily activity.

The prevalence of allergies in combined urban-rural areas (52.8%) may be influenced by a combination of factors from both environments. Individuals living in these areas may experience the effects of air pollution from nearby urban centers, higher levels of air pollution, including particulate matter, nitrogen oxides which can exacerbate allergic reactions and increase the risk of developing allergies. While also being exposed to rural environmental factors, such as agricultural allergens or natural environments. Residents of both urban and rural areas showed the highest allergy prevalence. This indicates that mixed environments expose individuals to a broader range of allergens. The worldwide prevalence of allergic disease is rising as a result of complex gene-environment interactions that shape the immune system and host response **(Murrison et al., 2019).**

In our study, the dust was identified as the primary cause of allergies (38.7%), followed by chemicals (27.6%) and plants (16%). This indicates that allergies have a multifactorial nature, where both environmental pollutants and biological allergens play critical roles. According to the study of **Cuesta-Herranz et al. (2000)**, pollinosis is the major cause of allergy, indicating that most patients allergic to pollens were sensitized to grass (Lolium and Phleum; 97.9%), followed by tree (Olea; 82.1%) and weed pollens (Plantago; 64.2%).

Concerning, the relation between the time spent outside per day and pollinosis, we found that people who spend 6 hours outside the home are the most susceptible to allergy, and people who spend 8 and 4 hours are the least affected. Spending more time outdoors increases the exposure to environmental allergens, such as pollen from trees, grasses, and weeds, which can trigger allergic reactions in susceptible individuals.

However, the specific time frame of 6 hours spent outside may coincide with peak pollen counts or increased levels of outdoor allergens. Certain times of the day, such as early morning or late afternoon, may have higher concentrations of airborne allergens, contributing to the increased prevalence of allergies among those spending 6 hours outside. On the other hand, individuals who spend 8 hours and 4 hours outside are the least affected by allergies. This could be due to the specific time frames of 8 hours and 4 hours spent outside may not coincide with peak allergen levels, reducing the likelihood of allergic reactions. According to **Ziska et al. (2019)**, extended outdoor activities correlate with higher allergen exposure and subsequent allergy symptoms. It's implied that increased outdoor exposure directly correlates with higher allergy incidence due to prolonged contact with airborne allergens **(Levetin & Van de Water, 2008)**. Individuals spending 6 hours outside were most susceptible to allergies in our study, suggesting an optimal exposure window for allergen sensitivity, and it could be correlates with allergen exposure and allergy incidence. Our epidemiological survey showed a significant portion (68.9%) of participants consulted a doctor, with 84.5% completing their treatment and 89.3% reporting improvement.These findings highlight the importance of medical intervention and adherence to treatment in managing allergies. **Fokkens et al. (2012)** showed that effective medical intervention and adherence improve allergy management outcomes.

The results obtained in our epidemiological survey indicate that all age groups can be affected by the allergy. However, peoples aged between 40-50 and 50-60 seem the most sensitive and the ages 15-20 are less likely to suffer from allergies. These results show that as individuals age, their immune system undergoes changes, and its ability to respond effectively to environmental stimuli, including allergens, may decrease. **Simon et al. (2015)**, indicate that immune function can decline with age, making older adults more susceptible to allergic diseases, potentially linked to age-related immune changes, and this is what he mentioned.

Concerning the causes of allergy by age group, we noticed that the plants, chemical products and animals are the main causes of allergies for all age groups. However, the age groups 15-20, 30-40, and 50-60 years are the most sensitive.

Chemical products and dust were the primary causes across all age groups, with heightened sensitivity in the 15-20, 30-40, and 50-60 age groups. Due to the lack of knowledge of the individuals surveyed, dust and plants are directly linked to pollen. Dust allergy can be due to the presence of pollen and not to particulate matter suspended in the air. The heightened sensitivity in the 15-20, 30-40, and 50-60 age groups could be attributed to the increased time spent outdoors during spring/summer, bringing pollen into indoor environments. And the immune system changes; during adolescence (15-20) and older age (50-60), hormonal and immune system changes can increase sensitivity to allergens like pollen.

According to **Calderón et al. (2015)**, dust can be a source of various allergens, including those of occupational origin, which can contribute to the increased sensitivity observed in certain age groups.

The predominant wind direction in autumn is from the northwest (NW), followed by the southwest (SW). This suggests that allergens, particularly from forested areas and agricultural fields located to the NW, are likely transported into Zoui during this season.

The NW winds carry pollen from forested and agricultural areas, contributing to the high allergy prevalence in autumn. This is supported by studies such as those by **Davies and Smith (1973)**, which emphasize the role of wind in pollen dispersal. 52 In spring, the NW and SW winds remain predominant, with notable contributions from the northeast (NE). This aligns with the increased prevalence of allergies reported during this season due to the dispersion of pollen from both natural and cultivated plants in these directions. A comparison with research by **Emberlin et al. (2000)**, highlights the significant impact of spring winds on pollen distribution and allergy symptoms, supporting the findings in Zoui.

During winter, NW winds are the most dominant, followed by winds from the west (W). These strong and frequent NW winds suggest that pollen from forest and agricultural sources in the NW direction can travel long distances, impacting residents significantly.

In summer, the NW winds are again predominant, with significant contributions from the north (N) and northeast (NE). This pattern indicates continuous exposure to pollen and allergens from the NW forest and agricultural areas, exacerbating summer allergies.

The vegetation cover around Zoui, including Pinus halepensis forests, Quercus suber, and various crops, provides a continuous source of allergens. The NW winds are particularly impactful due to the dense forest and agricultural areas in that direction. The seasonal wind patterns indicate that pollen from these areas is transported into Zoui city, contributing to the high prevalence of allergies reported in the survey. Similar studies by **Carinanos et al. (2000)** in Mediterranean climates have shown that wind direction and local vegetation significantly influence pollen dispersal and allergy incidence.

Conclusion

The present study highlights the significant impact of environmental factors and demographic characteristics on the prevalence of allergies in the Zouï region. The findings underscore the pivotal role played by wind direction and local vegetation in the dispersal of pollen and other allergens, contributing to the high incidence of pollinosis reported in the area.

The epidemiological survey revealed that dust, chemical products, and plant allergens are the primary causes of allergies across all age groups, with heightened sensitivity observed in individuals aged 15-20, 30-40, and 50-60 years. These age-related differences in allergy susceptibility can be attributed to various factors, including occupational exposures, lifestyle patterns, and age-associated changes in the immune system.

Notably, the study found that individuals spending 6 hours per day outdoors are the most susceptible to allergies, potentially due to increased exposure to environmental allergens during peak allergen levels or specific time frames. This finding underscores the importance of considering time spent outdoors as a risk factor for allergic reactions.

The study also highlighted the crucial role of medical intervention and adherence to treatment in managing allergies effectively. A significant portion of participants sought medical consultation and reported improvement after completing their prescribed treatment, emphasizing the importance of access to healthcare and patient compliance in alleviating allergy symptoms.

The complex interplay between environmental factors, occupational exposures, age-related immune system changes, and lifestyle patterns highlights the multifaceted nature of allergies in the Zouï region. Future research should further investigate the specific mechanisms underlying the observed age-related differences in allergy susceptibility, as well as explore innovative strategies for mitigating the impact of environmental and occupational allergens. Additionally, longitudinal studies examining the long-term effects of allergen exposure and treatment adherence on allergy management outcomes would provide valuable insights.

Bibliographic references

-A-

- **Abou Chakra, O.(2009).** Allergénicité des Granules Cytoplasmiques de Pollen. Thèse de Doctorat, Ecole Doctorale Abies. Paris, 200 p
- **Abramson, S. L. (2018).** Reducing environmental allergic triggers: policy issues. The Journal of Allergy and Clinical Immunology: In Practice, 6(1), 32-35.
- **Allague,Z.,Nadjuo,H.(2013).** La biodiver de la folore de la cèdraie de la montagne de chèlia dans willaya de khenchela.thème de mèmoire de l'universitè de khenchela ,2-10p.
- **Alnahas, S., Abouammoh, N., Althagafi, W., & Abd-Ellatif, E. E. (2023).** Prevalence, severity, and risk factors of allergic rhinitis among schoolchildren in Saudi Arabia: A national cross-sectional study, 2019. The World Allergy Organization journal, 16(10), 100824.
- **ANSES** . Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail (2014). État des connaissances sur l'impact sanitaire lié à l'exposition de la population générale aux pollens présents dans l'air ambiant, n° 2011-SA-0151, éd scientifique, P217
- **Arakawa, H., & Morikawa, A. (2004)**. The genetics of pollinosis. Clinical & Experimental Allergy Reviews, 4(1), 3-7.
- **Aurilie,S.(2009).**Les Allergies respiratoires a travers la presse ecrite ,enquete aupres de lecteurs.Université Henri Poincare –Nancy 1.

-B-

- **Ballmer-Weber, B. K., Scheurer, S., Fritsche, P., Enrique, E., Cistero-Bahima, A., Haase, T., & Wüthrich, B. (2002).** Component-resolved diagnosis with recombinant allergens in patients with cherry allergy. Journal of allergy and clinical immunology, 110(1), 167-173.
- **Bartra ,J.(2009).**From Pollinosis to Digestive Allergy . Ournal of Investigational Allergology and Clinical Immunology 19 Suppl 1:3-10
- **Beggs, P. J. (2021).** Climate change, aeroallergens, and the aeroexposome. Environmental Research Letters, 16(3), 035006.
- **Bousquet J, Van Cauwenberge P, Khaltaev N.(2001)**. Allergic rhinitis and its impact on asthma. J Allergy Clin Immunol 2001;108:S147-334

- **Bousquet, J., Heinzerling, L., Bachert, C., Papadopoulos, N. G., Bousquet, P. J., Burney, P. G., ... & Demoly, P. (2012).** Practical guide to skin prick tests in allergy to aeroallergens. *Allergy*, *67*(1), 18-24.
- **Brożek , (2015)**:Allergic rhinitis and its impact on asthma (ARIA) guidelines Allergy -Clin Immunol (2017).

-C-

- **Capone, P.; Lancia, A.(2023).** D'Ovidio, M.C. Interaction between Air Pollutants and Pollen Grains: Effects on Public and Occupational Health. Atmosphere 2023, 14, 1544)
- **CENEAP**: Centre National d'Études et d'Analyses pour la Population et le Développement (National Center for Studies and Analysis for Population and Development)
- **Charpin, J. (2004)** . Les pollens, les pollinoses et autres maladies respiratoires allergiques, service pneumo-allergologie de l'hôpital Nord France .p10.
- **Chermat,S.,Beldjazia ,A.,and Missaoui ,K.(2019).**Diagnosticn ecologique et impact sanitaire des plantes allergisantes a visee ornemontale dans les hautes plainessetifienne , vol 9
- **Choi, Y. J., Lee, K. S., & Oh, J. W. (2021).** The impact of climate change on pollen season allergic sensitization to pollens. Immunology allergy Clinics, 41(1), 97-109.
- **Choukry,K .(2017)** . Les plantes à pollen allergissant en Algérie,Département de Pharmacie,Faculté de Médecine . Université Abou Bekr Bekaid,Tlemcen 30p.
- **Ciani, Francesco & Marchi, Giovanna & Dell'Olmo, Lorella & Foggi, Bruno & Mariotti Lippi, Marta. (2020).** Contribution of land cover and wind to the airborne pollen recorded in a South European urban area. Aerobiologia. 36. 10.1007/s10453-020-09634-y.
- **Crimmins, A. R. (2019).** Temperature-related changes in airborne allergenic pollen abundance and seasonality across the northern hemisphere: a retrospective data analysis. *The Lancet Planetary Health*, *3*(3), e124-e131.
- **Cuesta-Herranz, J., Lazaro, M., Figueredo, E., Igea, J. M., Umpierrez, A., & De-Las-Heras, M. (2000)**. Allergy to plant-derived fresh foods in a birch-and ragweed-free area. Clinical & Experimental Allergy, 30(10), 1411-1416.
- **Corsico, R., Falagiani, P., Ariano, R., Berra, D., Biale, C., Bonifazi, F., Campi, P., Feliziani, V., Frenguelli, G., Galimberti, M., Gallesio, M. T., Liccardi, G., Loreti,**

A., Marcer, G., Marcucci, F., Meriggi, A., Minelli, M., Nardelli, R., Nardi, G., Negrini, C. A., … Riva, G. (2000). An epidemiological survey on the allergological importance of some emerging pollens in Italy. Journal of investigational allergology & clinical immunology, 10(3), 155–161.

- **Crespo, J. F., Bueno, C., Villalba, M., Monaci, L., Cuadrado, C., Novak, N., & Cabanillas, B. (2021).** Epitope mapping of the major allergen 2S albumin from pine nut. *Food chemistry*, *339*, 127895.

-D-

- **D’Amato ,G. (1998).**Pollen allergy in the mediterranean area. Revue française d’allergologie et d’immunologie clinique 1998;38 Suppl 7S:S160-S162.
- **D'Amato, G. (2002).** Environmental urban factors (air pollution allergens) and the rising trends in allergic respiratory diseases. Allergy, 57, 30-33.
- **D'amato, G., Liccardi, G., D'amato, M., & Holgate, S. (2005).** Environmental risk factors allergic bronchial asthma. Clinical & Experimental Allergy, 35(9), 1113-1124.
- **Didier,A., Mazereeuw-Hauter ,J., and Rancé,F.(2006).** Allergie et hypersensibilité. Ed. Elsevier. Paris, 62 p
- **Davies, R. R., & Smith, L. P. (1973).** Forecasting the start and severity of the hay fever season. *Clinical & Experimental Allergy*, *3*(3), 263-267.

-E-

- **Emberlin, J., Jaeger, S., Dominguez-Vilches, E., Soldevilla, C. G., Hodal, L., Mandrioli, P., ... & Bartlett, C. (2000)**. Temporal and geographical variations in grass pollen seasons in areas of west0ern Europe: an analysis of season dates at sites of the European pollen information system. *Aerobiologia*, *16*, 373-379.

-G-

- **Ghedir,N ;Kattoum,M. (2023).** Profil clinique et allergologique du pollinose dans la région de Khenchel. Thèse de Master Acadimique , Faculté des Sciences de la Nature et de la Vie,Département : Écologie et Environnement. p 35 .

- **Govaere, E., Gysel, D. V., Massa, G., Verhamme, K. M., Doli, E., & Baets, F. D. (2007).** The influence of age and gender on sensitization to aero-allergens. Pediatric allergy and immunology, 18(8), 671-678.
- **Gutowska-Ślesik, J., Samoliński, B., & Krzych-Fałta, E. (2023)**. The increase in allergic conditions based on a review of literature. Postepy dermatologii i alergologii, 40(1), 1–7.

-H-

- **Harf ,R.(2012).** Pollinoses: traitements médicamenteux [Pollinosis: drug treatments]. Rev Mal Respir.458-62.
- **Hashimoto, Y., Otani, T., Koyama, H., Iwasaki, M., Sasazawa, Y., & Suzuki, S. (2007).** [Nihon koshu eisei zasshi] Japanese journal of public health, 54(11), 792–804.
- **Heinzerling, L., Mari, A., Bergmann, K. C., Bresciani, M., Burbach, G., Darsow, U., ... & Lockey, R. (2013).** The skin prick test–European standards. Clinical and translational allergy, 3, 1-10.
- **Higaki, T., Okano, M., Makihara, S., Fujiwara, T., Haruna, T., Noda, Y., ... & Nishizaki, K. (2012).** Early interventional treatment with intranasal corticosteroids compared with postonset treatment in pollinosis. Annals of Allergy, Asthma & Immunology, 109(6), 458 464.

-J-

- **J.-W. Oh.(2018).** Pollen Allergy in a Changing World (Second edition) : springer
- **Jacques Robert (2015)** . La pollinose ou les troubles provoqués par les pollens , Centre Hospitalier Lyon Sud
- **Jacques, R. (2015)** .Pédiatre Allergologue. Questionnaire. La pollinose ou les troubles
- **James C. Thompson, George F. Kroker .(2010).** The role of component-resolved testing in food allergy and oral allergy syndrome .Annals of Allergy, Asthma & Immunology, Volume 104, Issue 6, June 2010, Pages 543.
- **Jenerowicz D, Silny W, Dańczak-Pazdrowska A, Polańska A, Osmola-Mańkowska A, Olek-Hrab K(2012).** Environmental factors allergic diseases. Ann Agric Environ Med. 2012; 19(3): 475-481.

-K-

- **Kalpaklioglu, A. F., Kalkan, I. K., Akcay, A., Reisli, I., Can, D., Uzuner, N., ... & Ediger, D. (2011).** (Un) Awareness of allergy. World Allergy Organization Journal, 4, 170-178.
- **Kitamura, Y., Nakagawa, H., Fujii, T., Sakoda, T., Enomoto, T., Mizuguchi, H., ... & Takeda, N. (2015).** Effects of antihistamine on up-regulation of histamine H1 receptor mRNA in the nasal mucosa of patients with pollinosis induced by controlled cedar pollen challenge in an environmental exposure unit. Journal of Pharmacological Sciences, 129(3), 183-187.
- **Krämer, U., Koch, T., Ranft, U., Ring, J., & Behrendt, H. (2000).** Traffic-related air pollution is associated with atopy in children living in urban areas. *Epidemiology*, *11*(1), 64-70.
- **Levetin, E., & Van de Water, P. (2008).** Changing pollen types/concentrations/distribution in the United States: fact or fiction?. Current allergy and asthma reports, 8(5), 418-424.

-M-

- **M.I. Asher,al. (2006).**Worldwide time trends in the prevalence of symptom of asthma, allergic rhinoconjunctivitis, and eczema in childhood ISAAC Phases One and Three repeat multicountry cross-sectiona surveys Lancet.
- -**Maya-Manzano, J. M., Sadyś, M., Tormo-Molina, R., Fernández-Rodríguez, S., Oteros, J., Silva-Palacios, I., & Gonzalo-Garijo, A. (2017).** Relationships between airborne pollen grains, wind direction and land cover using GIS and circular statistics. *Science of the Total Environment*, *584*, 603-613.
- **McInnes, R. N., Hemming, D., Burgess, P., Lyndsay, D., Osborne, N. J., Skjøth, C. A., Thomas, S., & Vardoulakis, S. (2017).** Mapping allergenic pollen vegetation in UK to study environmental exposure and human health. The Science of the total environment, 599-600, 483–499. https://doi.org/10.1016/j.scitotenv.2017.04.136.
- **Michael, A.J., Cambell-Lendrum, D.H., Corvalan, C.F., Ebi, K.L., Githeko, A., Scheraga, J.D., Woodward, A. (2003)** .Climate change and Human health. Risk and responses. Geneva. World Health Organization. 322p.
- **Molina,C.(1995).** L'allergie à l'aube du troisième millénaire. Ed. John LibbeyEurotext. Paris.103
- **Mondoul , L.(2005).** Diversité de la réponse IgE dans l'allergie à l'arachide, caractérisation des allergènes et devenir de leur potentiel allergénique lors des

traitements et des processus digestifs. [Thèse]. Institut national des sciences appliquées de Toulouse. France. 249p .

- **Murrison, L. B., Brandt, E. B., Myers, J. B., & Hershey, G. K. K. (2019).** Environmental exposures and mechanisms in allergy and asthma development. *The Journal of clinical investigation*, *129*(4), 1504-1515.

-N-

- **Nedkova,Milanova.,Vanya ,M.,Tsvetelina ,H.(2018).** Clinical Aspects of Food Allergy in Infants in Pleven Region, Bulgaria 10.2478/jbcr-2018-0006.

-O-

- **OESRP**: Office of environmental studies and regional planning , study for the development and classification of the Sebkhet El Mahmel wetland;Khabtane,A .

-P-

- **P.A.D.D:** Plan d'Aménagement et de Développement Durable (Sustainable Development and Planning Scheme)
- **Pablos, I., Wildner, S., Asam ,C., Wallner, M., Gadermaier, G.(2016).** Pollen Allergens for Molecular Diagnosis. Curr Allergy Asthma Rep. 2016 Apr;16(4):31. doi: 10.1007/s11882-016-0603-z. PMID: 27002515; PMCID: PMC4803804.
- **Pakkasela, J., Ilmarinen, P., Honkamäki, J., Tuomisto, L. E., Andersén, H., Piirilä, P., ... & Lehtimäki, L. (2020).** Age-specific incidence of allergic and non-allergic asthma. BMC pulmonary medicine, 20, 1-9.
- **Pence, HL. Mitchell, DQ. Greely, RL. Updegraff; BR.Selfridge ,HA. (1976).**Immunotherapy for mountain cedar pollinosis. A double-blind controlled study. J Allergy Clin Immunol. 1976 39-50.

-R-

- **Richard,D., Chevolet,P., and Fournel,S.(2012).** Biologie. éd. 2. p 604-603
- **RMPDRM**: Reviewing the master plan for development and reconstruction of the municipality,2018) of Ouled recheche .
- **Roche N., Huchon G. (2015)** .Article. Du symptôme au diagnostic toux. service de pneumologie, Hôtel-Dieu, Paris.

- **Rojo, J., Rapp, A., Lara, B., Fernández-González, F., & Pérez-Badia, R. (2015).** Effect of land uses and wind direction on the contribution of local sources to airborne pollen. The Science of the total environment, 538, 672–682.

-S-

- **Sakurai ,Y., Nakamura, K., Teruya, K., Shimada, N., Umeda, T., Tanaka, H., Yoshizawa, N. (1998)** . Prevalence and risk factors of allergic rhinitis and cedar pollinosis among Japanese men. Prev Med. 617-22. doi: 10.1006.
- **Sakurai, Y., Nakamura, K., Teruya, K., Shimada, N., Umeda, T., Tanaka, H., & Yoshizawa, N. (1998).** Prevalence and risk factors of allergic rhinitis and cedar pollinosis among Japanese men. Preventive medicine, 27(4), 617–622.
- **Saulyte, J., Regueira, C., Montes-Martínez, A., Khudyakov, P., & Takkouche, B. (2014).** Active or passive exposure to tobacco smoking allergic rhinitis, allergic dermatitis, and food allergy in adults and children: a systematic review and meta-analysis. PLoS medicine, 11(3), e1001611.
- **Scheifinger, H., Belmonte, J., Buters, J., Celenk, S., Damialis, A., Dechamp, C., ... & De Weger, L. A. (2013).** Monitoring, modelling and forecasting of the pollen season. Allergenic pollen: A review of the production, release, distribution and health impacts, 71-126.
- **Scheifinger, H., Belmonte, J., Buters, J., Celenk, S., Damialis, A., Dechamp, C., ... & De Weger, L. A. (2013).** Monitoring, modelling and forecasting of the pollen season. Allergenic pollen: A review of the production, release, distribution and health impacts, 71-126.
- **SIFI, A ., ANSER,A.,(2018).** MÉMOIRE DE MASTER ACADEMIQUE en Biologie. Analyse Aéropalynologique Automnale et Manifestation Allergique(La Ville de Khenchel) . Université Abbés Laghrour -Khenchela- .
- **Siles, R. I., & Hsieh, F. H. (2011).** Allergy blood testing: A practical guide for clinicians. Cleve Clin J Med, 78(9), 585-92.
- **Silly Ysabelle and Pomburcq Caroline (2014)** . Allergie au pollen,éd.santé magazine .
- **Silva Palacios, I., Tormo Molina, R., & Muñoz Rodríguez, A. F. (2000).** Influence of wind direction on pollen concentration in the atmosphere. International Journal of Biometeorology, 44, 128-133.

- **Silva Palacios, I., Tormo Molina, R., & Nuñoz Rodríguez, A. F. (2000).** Influence of wind direction on pollen concentration in the atmosphere. International journal of biometeorology, 44(3), 128–133.
- **Sivaguru, M., Mander, L., Fried, G., & Punyasena, S. W. (2012).** Capturing the surface texture and shape of pollen: a comparison of microscopy techniques. PloS one, 7(6), e39129.
- **Sophie A, Valérie B, Denis C, Joëlle D, Emilie F,al.(2018)** .État des connaissances relatif à l'impact sanitaire de l'exposition aux moisissures présentes dans l'air ambiant sur la population générale française et recommandations en matière de surveillance nationale. Saisine n°-SA-0011, 2020, 204 p.
- **Stach, A., García-Mozo, H., Prieto-Baena, J. C., Czarnecka-Operacz, M., Jenerowicz, D., Silny, W., & Galán, C. (2007).** Prevalence of Artemisia species pollinosis in western Poland: Impact of climate change on aerobiological trends. J Investig Allergol Clin Immunol, 17(1), 39-47.

-T-

- **Thibaudon, M., Sulmont, G., Caillier, J(1992)** .Pneumallergène polliniques, traité d'allergologie. Edition Flammarion, Médecine, Sciences, chapitre 33 : 409-463p
- **Thornhill, S. M., & Kelly, A. M. (2000).** Natural treatment of perennial allergic rhinitis. Alternative Medicine Review, 5(5), 448-454.

-U-

- **Undem, B. J., & Taylor-Clark, T. (2014).** Mechanisms underlying the neuronal-based symptoms of allergy. Journal of allergy and clinical immunology, 133(6), 1521-1534.

-V-

- **Vieths, S., Scheurer, S., & BALLMER-WEBER, B. A. R. B. A. R. A. (2002).** Current understanding of cross-reactivity of food allergens and pollen. Annals of the New York Academy of Sciences, 964(1), 47-68.

-W-

- **Wu, A. C., Dahlin, A., & Wang, A. L. (2021).** The role of environmental risk factors on the development of childhood allergic rhinitis. Children, 8(8), 708.

-Z-

- **Ziska, L. H., Makra, L., Harry, S. K., Bruffaerts, N., Hendrickx, M., Coates, F., ... & Simons, F. E. R., Ebisawa, M., Sanchez-Borges, M., Thong, B. Y., Worm, M., Tanno, L. K., ... & Sheikh, A. (2015).** 2015 update of the evidence base: World Allergy Organization anaphylaxis guidelines. *World Allergy Organization Journal*, *8*, 32.
- **Zielhuis, G.A., et al. (1990).** The influence of selection on the distribution of occupation and smoking habits in a survey of respiratory symptoms. *International Journal of Epidemiology*, 19(1), 60-66.