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RESEARCH ARTICLE

Assessment of parthenium hysterophorus aeroallergens and allergic patient prevalence in Chapra town, Bihar state, India

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Abstract

Parthenium hysterophorus is an extremely invasive plant species widely spread across various regions, including India. It is recognized for emitting airborne allergens, which have the potential to induce allergic responses in susceptible individuals. The objective of this study was to examine the prevalence of allergies triggered by parthenium among individuals with allergies living in Chapra town, Bihar, India. The research spanned a two-year period from 2018 to 2020, and the RotoRod Sampler method was utilized to gather data on environmental parameters. Daily information on environmental conditions was obtained from the Bihar Meteorological Department, while data on pollen allergy patients were collected from Sadar Hospital in Chapra. The investigation reports of patients belonging to different age groups were compiled for analysis. The findings indicated that the high concentration of parthenium pollen in the air had significant implications for pollinosis. The spring season is associated with the highest recorded levels of pollen, and there is a clear connection between the release of pollen and the number of individuals suffering from allergies. This correlation affects both local residents and people visiting the area during the peak period of the year. It is recommended that authorities and forest departments exercise caution when selecting invasive species for plantation.

Keywords: Aeroallergens, Environmental conditions, *P. hysterophorus*, Patients.

Introduction

Aeroallergens play a major role in the pathogenesis of respiratory allergic diseases, particularly asthma and rhinitis. Pollen, fungi, animal danders, house dust mites, domestic pets, and insects are of particular importance as triggering factors. Pollen grains, characterized by their dusty and powdery texture, typically have a spherical shape and a diameter ranging from 25 to 50 micrometers (Nayab and Alam 2023). Pollen grains are well studied as important aeroallergens causing pollinosis (Singh and Kumar 2003). The Compositae weed, *P. hysterophorus* (American feverfew), which is related to *Ambrosia (ragweed),* is native to Argentina, Mexico, the West Indies, and southern parts of the U.S.A. It is presumed to have been accidentally introduced into India around 1956, along with imported wheat grains, and more recently to Australia. After its initial appearance in Poona city, the weed soon became adapted to Indian soil and climate, spreading extensively to many parts of India (Sriramarao *et al.*1991). *P. hysterophorus,* often referred to as "*congress grass*" or "*gajar ghas*," is an invasive weed that has infested agricultural lands and urban areas in India. This troublesome plant has resulted in significant economic losses and health risks. It causes allergic respiratory problems, contact dermatitis, and mutagenicity in humans (Joseph *et al.* 2015). The excessive spread and overpowering nature of this weed pose a significant risk to the variety of life forms in the ecosystem. It is an annual herbaceous plant notorious for its allergenic properties, triggering allergic responses in both humans and animals as shown in Figure 1. The pollen grains of *P. hysterophorus* have been recognized as strong airborne allergens, capable of causing serious respiratory allergies like rhinitis, asthma, and conjunctivitis when inhaled.

The incidence of *parthenium allergy* has noticeably risen in different regions of India, including Bihar, in recent times. The prevalence and risk factors associated with *parthenium allergy* in the state of Bihar, particularly in Chapra town, are not well-documented. The objective of this study is to analyze the prevalence of *parthenium*

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Figure 1: *Parthenium hysterophorus* plant Species

allergy among individuals with existing allergies residing in Chapra town, Bihar, India, with the intention of gaining a thorough comprehension of this matter. Furthermore, the research seeks to identify the specific substances that trigger allergic responses. The study provided valuable insights into the prevalence and patterns of *parthenium allergy* in the region and helped in developing effective prevention and management strategies for the condition.

This study was conducted due to the limited availability of comprehensive data on the prevalence of *parthenium allergy* and the factors that contribute to it in Bihar state, India. Its objective is to assess the prevalence of *parthenium allergy* among individuals with allergies in Chapra town and determine the specific allergens responsible for allergic reactions. The research spanned a two-year period from 2018 to 2020, and the RotoRod Sampler method was utilized to gather data on environmental parameters. By providing valuable insights into the prevalence and patterns of *parthenium allergy* in the region, the study has contributed to the development of effective prevention and management strategies for this condition. Furthermore, the findings have expanded the understanding of the influence of aeroallergens on respiratory allergies, leading to significant implications for the overall health of the public. The results of this study add to the existing understanding of aeroallergens and their impact on respiratory allergies, potentially influencing public health in meaningful ways.

Materials and Method

Geographical Conditions of the Study Area

Chapra is a small town located in the Saran district of Bihar. The specified coordinates for this location are approximately 25.78480°N latitude and 84.72740°E longitude, with an elevation of 118 ft. It is situated close to the point where the Ganges and Ghaghara rivers meet. Chapra is around 70 kilometers away from Patna, the capital city of Bihar. The area is advantageous due to its rich and fertile soil, making it highly suitable for agricultural activities. Chapra experiences a tropical climate characterized by an average yearly temperature of 24.9°C. The city typically has an annual rainfall average of 1059 mm. February is the driest month, experiencing only 2 mm of rain. On the other hand, July receives the highest amount of precipitation, with an average of 328 mm. May is the month with the highest temperatures, with an average of 33.1 degrees Celsius, whereas January experiences the coldest temperatures, averaging 18.5 degrees Celsius. Temperatures experience variations of approximately 14.6 degrees Celsius throughout the year. Chapra is located at the southern edge of the Ganges River, with the Gandak River forming its eastern border. The Ghaghra River serves as a natural dividing line separating Saran and Ballia, with its location in the Indo-Gangetic plains and the predominant soil composition being Gangetic alluvium. This type of soil is known for its fresh loamy composition, which gets renewed every year when floods bring in deposits of sand, clay, and silt. Chapra is susceptible to floods due to its close proximity to the Ganges and Ghaghra rivers, leading to the formation of different low-lying areas and wetlands. The spring season typically occurs from February to March. Geographical map of the study area is shown in Figure 2.

Study Area

The current research focuses on examining the pollen flora and creating reference slides to identify specific pollen found in the samples. This allows for a qualitative and quantitative assessment of the pollen present in the air of Chapra Town. A comprehensive inquiry was carried out on location throughout the district, which was subsequently followed by a thorough analysis of the plant life in the vicinity. Polliniferous materials were gathered, and frequent visits were conducted to nearby areas to collect them. During the collection, observations were made on the flowering periods, flower colors, flower sizes, and pollination mechanisms of collected plants. The selected locations for the study are Gandhi Chawk, Nehru Chawk, Chhota Telpa, Newazi Tola, Sadhnapuri, Kareem Chawk, and Katharibagh.

Data Sampling and Data Analysis

The IMD provided daily environmental parameter data from 2018 to 2020, while data on pollen allergy patients were

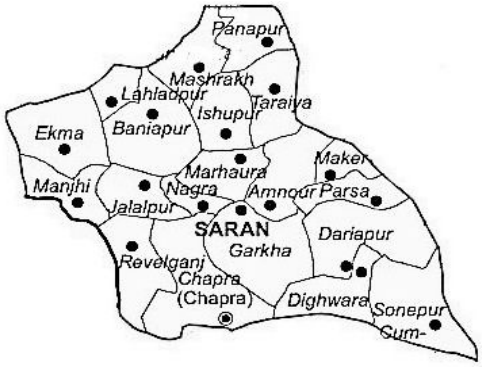

Figure 2: Geographical map of the study area

gathered from Chapra Sadar Hospital. The information was obtained from investigation reports of patients of various age groups who sought treatment at Sadar hospital in Chapra during the allergy season from February to April.

The Rotorod Sampler device comprises small leucite rods, ranging in size from 1 to 3 mm, coated with adhesive silicon grease as shown in Figure 3. These rods are used to trap particles suspended in the atmosphere. The Rotorod Sampler is a compact and portable device that runs on DC power, allowing for adjustable exposure time to meet specific needs. This sampler is commonly used to continuously analyze both pollen and fungal spore types, helping to minimize the risk of allergic reactions in susceptible individuals.

The Rotorod sampler technique was used to examine the existence of *P. hysterophorus* pollen particles in the atmosphere. This sampling technique demonstrates its effectiveness irrespective of the speed or direction of the wind, ensuring a strong level of efficiency in capturing around 65% of particles within the size range of 12.24-24.48 µm, which encompasses pollen grains.

Approximately 60 liters of air samples were collected per minute using a trapping apparatus. To avoid overwhelming the apparatus, it was operated intermittently for long-period samples. The trapping apparatus was positioned at a height of 15 meters above the ground, and pollen samples were collected continuously from 7 am to 7 am the next day. To ascertain the pollen count, the amount of specific pollen particles present in each cubic meter of air collected during a 24-hour span was computed.

A glass slide measuring 75 by 26 mm and approximately 1 mm in thickness was employed, coated with glycerin to capture pollen grains from the surrounding atmosphere. This process was repeated every morning for a duration of fifteen minutes. The laboratory examination of trapped pollens was done. They were placed on a glass slide and analyzed using an electron microscope.

Among the various plant species, *P. hysterophorus* pollens were found to be present in higher concentrations. Temperature measurements, ranging from minimum to maximum, were recorded using a thermometer. The data were then analyzed and processed using Microsoft Excel 2007 to display the spatial and temporal relationship between *P. hysterophorus* pollen, temperature, and their effects on human health.

Figure 3: Rotorod sampling device

Examination and Analysis of Air Samples

Air samples were examined using an electron microscope.

Pollen Counting

Every day, the procedures outlined in the manual titled "Guide to Trapping and Counting" by the British Aerobiological Federation were followed to conduct pollen counting. The process involved recording the quantity of pollen grains per cubic meter of air at regular intervals throughout the day.

Data Collection for Skin Prick Test

Collected data for a skin prick test involved gathering information regarding the test subjects, their medical history, the substances tested, and the results of the test. Skin Prick Testing data were collected monthly from the outpatient department (OPD) of Sadar Hospital in Chapra. The data were documented in Excel spreadsheets, arranged chronologically for each month. The overall outcomes were determined by summing up the monthly figures from all the sheets.

Estimation of the Prevalence of Pollen Allergy Using the Following Formula:

$$\text{The prevalence ratio (PR)} = \frac{\text{Number of Skin Prick tests positive for Parthenium in a given period}}{\text{Number of Total Skin Prick tests during this period}} \times 100\%$$

Result

Annual pattern of *P. hysterophorus* pollens

The *P. hysterophorus* plant exhibited a yearly cycle with a prolonged period of pollen production that began in March and lasted until November, reaching its peak concentration in August. The plant showed two separate blooming phases annually, with one occurring between February and April and the other taking place from July to October. In 2018, there were two significant peaks in *parthenium* pollen levels. The first peak occurred in March, with a concentration of 69 pollen per cubic meter (69 pollen/m^3), while the second peak happened in August, with a concentration of 74 pollen/m^3. The first flowering season started around mid-February and reached its lowest point in June, with only 6 pollen/m^3. The second season commenced in July and peaked in August, gradually declining until December when it reached a level of 11 pollen particles per cubic meter. In the year 2020, there were two high points in *parthenium pollen* levels. The first peak occurred in May with a concentration of 15 pollen per cubic meter, while the second peak was observed in August with a concentration of 32 pollen per cubic meter. The initial flowering season started in mid-March and reached a minimum level of two to three pollen per cubic meter in June. The second season started in July and reached its highest point in August before gradually decreasing to a level of five pollen particles per cubic meter by January. During both years, it was observed that *P. hysterophorus*

Table 1: *Parthenium* pollen and its seasonal contribution

Pollen Type	*Family*	*Pollen Contribution (%)*	*Season*
Parthenium hysterophorus	Asteraceae	35.5	Throughout the Year

exhibited its peak pollen levels in August and September. The occurrence of monsoon rains, especially in July, in the latter part of the year leads to an increased quantity of pollen during the plant's second blooming period. In 2018, the concentration of *parthenium* pollen was 339 pollen per cubic meter, while in 2020, it was 134 pollen per cubic meter. This indicates that the amount of *parthenium pollen* was significantly higher in 2018 compared to 2020.

Pollen Calendar

Table 1 shows the mean pollen concentration recorded over a span of two years, measured in the quantity of pollen particles per cubic meter.

Prevalence of Pollen Allergy

Data were collected from Sadar Hospital, Chapra, and skin prick tests were conducted. Data were estimated using the above formula. The formula employed to calculate the prevalence ratio of positive skin prick tests for *Parthenium* during a specific period can be restated as follows:

$$PR = \frac{\text{Number of positive skin prick tests for Parthenium}}{\text{Number of total skin prick tests during the same period}} \times 100\%$$

Effect of *P. hysterophorus* and Prevalence of Pollen Allergy

The Table 2 provides information on the overall number of individuals who underwent Skin Prick Testing (SPT) to detect allergies in the years 2018 and 2020. In 2018, 100 patients underwent SPT, while in 2020, the number increased to 120 patients. *Parthenium hysterophorus* is a poisonous

Table 2: Patient for SPT suffering from the very severe allergy, severe allergy and the Moderate allergy

Total Patient for SPT	*Year 2018*	*Year 2020*
	100	*120*
Patients having very severe allergy	40	55
Patients having severe allergy	15	20
Patients having moderate allergy	7	10

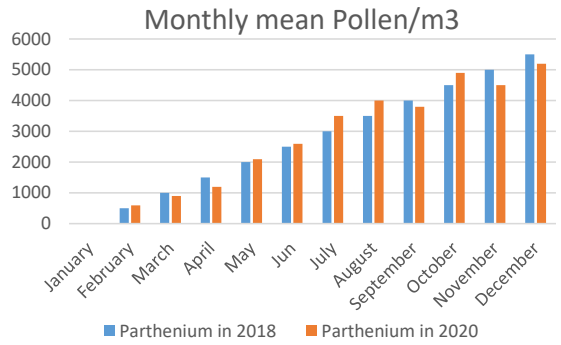

Figure 4: *Parthenium pollen* frequency in chapra during the period 2018-2020

weed that has spread across the length and breadth of the Indian subcontinent. It is a common cause of dermatitis similar to other members of the family, such as ragweed and chrysanthemums (Sharma *et al.* 2023). Additionally, the Table 2 provides a breakdown of patients with varying levels of allergy severity. In 2018, out of the total patients, 40 had very severe allergies, 15 had severe allergies, and 7 had moderate allergies. In 2020, the numbers increased, with 55 patients having very severe allergies, 20 patients having severe allergies, and 10 patients having moderate allergies. Overall, the Table 2 shows an increase in the total number of patients undergoing SPT between 2018 and 2020. During that time, there was an observable increase in the frequency of individuals suffering from extremely intense and significant allergic reactions.

The data in Table 3 displays the count of patients who underwent Skin Prick Test (SPT) and indicates the number of individuals among them who tested positive for an allergy to *Parthenium*. The Table 3 provides data for each month of the year 2018.

In January, there were a total of 105 patients who underwent SPT, out of which 15 were found to be allergic to *Parthenium*. This means that approximately 14.28% of patients tested positive for *Parthenium allergy* in January. In February, there were 82 patients who underwent SPT, and 20 of them were allergic to *Parthenium*. The percentage of patients with *Parthenium allergy* in February was approximately 24.39%. In March, out of 95 patients who had SPT, 40 were found to be allergic to *Parthenium*, making up approximately 42.10% of tested patients. In April, there were 160 patients who underwent SPT, and 60 of them

Table 3: Month wise identification of *Parthenium* pollen (year 2018)

Month	*Jan*	*Feb*	*March*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sept*	*Oct*	*Nov*	*Dec*
Total Patient for SPT	105	82	95	160	220	130	200	215	200	100	90	75
Allergic to Parthenium	15	20	40	60	50	30	60	70	40	20	15	10
%	14.28	24.39	42.10	37.5	22.72	23.07	30	32.5	20	20	16.66	13.33

Table 4: Month wise identification of *Parthenium* pollen (year-2020)

Month	*Jan*	*Feb*	*March*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sept*	*Oct*	*Nov*	*Dec*
Total Patient for SPT	120	100	80	75	85	90	100	110	115	65	55	50
Allergic to Parthenium	16	18	60	40	20	15	25	50	30	28	26	10
%	13.33	18	75	53.33	23.52	16.66	25	45.45	26.086	43.076	47.27	20

Table 5: Age group of patients, number of patients and percentage (Year 2018)

Age group	*Number of patients*			*Percentage*		
0-15 Year	*Male*	*Female*	*Total*	*Male*	*Female*	*Total*
16-30 year	2	3	5	40	60	100
31-45 Year	5	6	11	45.45	54.55	100
46-60 Year	7	4	11	63.63	36.36	100
>60 yrs.	5	4	9	55.55	44.44	100
Total	19	17	36	52.77	47.23	100

were allergic to *Parthenium*. This represents approximately 37.5% of patients tested. In May, out of 220 patients who had SPT, 50 were allergic to *Parthenium,* accounting for approximately 22.72% of tested patients. In June, there were 130 patients who underwent SPT, and 30 of them were allergic to *Parthenium*. This makes up approximately 23.07% of tested patients. In July, out of 200 patients who had SPT, 60 were found to be allergic to *Parthenium,* representing approximately 30% of tested patients. In August, there were 215 patients who underwent SPT, and 70 of them were allergic to *Parthenium*. This accounts for approximately 32.5% of tested patients. In September, out of 200 patients who had SPT, 40 were allergic to *Parthenium,* making up approximately 20% of tested patients. In October, there were 100 patients who underwent SPT, and 20 of them were allergic to *Parthenium*. This represents approximately 20% of tested patients. In November, out of 90 patients who had SPT, 15 were found to be allergic to *Parthenium,* accounting for approximately 16.66% of tested patients. In December, there were 75 patients who underwent SPT, and 10 of them were allergic to *Parthenium*. This makes up approximately 13.33% of tested patients. The Table 4 provides information about the total number of patients undergoing SPT (Skin Prick Test) each month throughout the year. It also specifies the number of patients who are allergic to *Parthenium,* a type of allergen. In January, there were 120 patients undergoing SPT, out of which 16 were allergic to *Parthenium*. In February, there were 100 patients, with 18 allergic to *Parthenium*. In March, there were 80 patients, and a significant increase in the number of *Parthenium allergies*, with 60 patients being affected. April saw 75 patients, with 40 allergic to *Parthenium*. As we move into the summer months, May had 85 patients, with 20 allergic to *Parthenium*. June had 90 patients, and 15 were allergic. July had 100 patients, with 25 allergic. In August, there were 110 patients, and a substantial rise in *Parthenium allergies*, with 50 patients affected. In September, there were 115 patients, with 30 allergic to *Parthenium*. October saw a decrease in both the total number of patients (65) and *Parthenium allergies* (28). November had 55 patients, and 26 were allergic. Lastly, December had the lowest numbers, with 50 patients and 10 being allergic to *Parthenium*. The Table 4 also provides the percentage of patients allergic to *Parthenium* for each month. These percentages vary throughout the year, ranging from 13.33% in January to 75% in March. Overall, it shows the fluctuating number of patients undergoing SPT and the varying prevalence of *Parthenium allergies* during the different months of the year 2020. Figure 4 illustrates the fluctuating Parthenium pollen frequency in Chapra from 2018-2020, offering insights into seasonal patterns. Figure 5 shows a patient undergoing Skin Prick Testing (SPT), a crucial diagnostic tool for identifying allergens, highlighting the correlation between environmental factors and allergies.

Table 6: Age group of patients, Number of patients and Percentage (Year 2020)

Age group	*Number of patients*			*Percentage*		
	Male	*Female*	*Total*	*Male*	*Female*	*Total*
0-15 year	1	0	1	100	0	100
16-30 year	6	4	10	60	40	100
31-45 year	8	6	14	57.14	42.86	100
46-60 year	5	3	8	62.5	37.5	100
>60 years	3	2	5	60	40	100
Total	23	15	38	60.5	39.5	38

Discussion and Conclusion

Parthenium dermatitis poses a significant challenge in both urban and rural India. Patients with severe allergic rhinitis, exposed to parthenium pollens, reportedly exhibit *parthenium-specific IgE* and *IgG antibodies* (Sriramarao

Figure 5: A patient suffering from Allergy and having SPT

et al.1991). *Parthenium triggers* Type IV hypersensitivity, causing contact dermatitis, and Type-I hypersensitivity, inducing allergic rhinitis (Lakshmi and Srinivas 2007). Its aggressive growth has led to an almost epidemic incidence of allergic eczematous contact dermatitis (AECD) from trichome and pollen contact, along with allergic rhinitis caused by its pollen (Towers and Subba 1992). The pollen of *P. hysterophorus,* an alien weed growing wild in India, is identified as a potential source of allergic rhinitis. A clinical survey revealed that 34% of rhinitis patients and 12% of bronchial asthma patients gave positive skin-prick test reactions to *Parthenium pollen* antigen extracts (Rao and Rao 1985). Skin prick tests (SPTs) represent the cheapest and most effective method for diagnosing Type I hypersensitivity (Bains and Dogra 2015). Table 5 delineates patient distribution across age groups and gender, providing insights into the prevalence of *Parthenium allergies*. In the 16-30 age group there were 5 patients, comprising 40% males and 60% females. For the 31-45 age group, there are 11 patients, with 45.45% males and 54.55% females. In the 46-60 age group, there are 11 patients, with 63.63% males and 36.36% females. Patients above 60 years old total 9, with 55.55% males and 44.44% females. In patients with atopy, genetically predisposed individuals produce *IgE* antibodies in response to inhaled or ingested allergens, resulting in not only raised total serum *IgE* but also antigen specific *IgE* (Kumar et al 2012). This corresponds to 55.55% and 44.44%, respectively, of the patients in this age group. In summary, the Table 5 illustrates the distribution of patients across different age groups, providing the number of patients and their corresponding percentages based on gender within each age category. The Table 6 represents the distribution of patients in different age groups based on their gender, categorized as 0-15 years, 16-30 years, 31-45 years, 46-60 years, and above 60 years. In the 0-15 age group, there is 1 male patient, and no female patients, totaling 1 patient. Moving to the 16-30 age group, there are 6 male patients and 4 female patients, totaling 10 patients. The 31-45 age group consists of 8 male patients and 6 female patients, resulting in a total of 14 patients. In the 46-60 age group, there are 5 male patients and 3 female patients, totaling 8 patients. Finally, in the age group above 60 years, there are 3 male patients and 2 female patients, resulting in a total of 5 patients. Overall, across all age groups, there are 23 male patients and 15 female patients, with a total of 38 patients. It is recommended that government authorities responsible for the capital city and forest departments should be mindful when choosing invasive species for planting purposes. They should exercise caution and consider the potential impacts of these species on the environment. Furthermore, it is essential to raise public awareness about preventive measures through various media platforms such as print, electronic, and social media. Based on the data-driven findings, it is recommended that comprehensive public awareness campaigns be initiated at the state and national levels to educate the public on the health risks of *Parthenium allergy*. Concurrently, the establishment of a robust monitoring system for *Parthenium pollen* concentration, coupled with strict land use planning and invasive species management, should be prioritized. Strengthening medical infrastructure and preparedness, fostering interdisciplinary collaboration between health and agricultural departments, and enacting legislation to regulate *Parthenium* cultivation are crucial steps. Additionally, international cooperation for information exchange and encouraging research on allergen-specific therapies will further enhance mitigation efforts. Implementing these measures will not only alleviate the burden of *Parthenium-induced allergies* but also contribute to long-term environmental and public health improvements. It is important to prioritize awareness initiatives regarding the rapid proliferation of *Parthenium* and its detrimental effects.

Ethical Consideration

This study was conducted after obtaining approval from the Human Ethical Committee of Sadar Hospital of Chapra (Clearance Number: E456, Date: 17/12/2017). Informed consent was obtained from all participants involved in the study.

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