

Epidemiological study on the extent of pneumonia infection among children in the Holy Karbala Governorate for the year 2025

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ABSTRACT

Pneumonia is considered one of the most dangerous acute respiratory infections, as it leads to the accumulation of fluid and pus in the alveoli, which impairs gas exchange and poses a major health threat, particularly in developing countries. This study aims to analyze the epidemiological distribution of the disease by examining demographic factors such as age and sex, alongside seasonal patterns, in order to identify the populations most vulnerable to infection and the periods of peak incidence. The study included a total sample of 905 cases, with data distributed and statistically analyzed across four age groups ranging from under one year to 14 years. Comparisons were also made according to sex and monthly temporal distribution throughout the year. The results revealed that children aged 1–4 years were the most vulnerable to infection, accounting for 378 cases (42%), while the age group of 10–14 years recorded the lowest infection rate at 14%. A clear disparity was observed in favor of males, who accounted for 59.6% of total cases compared to 40.4% for females, yielding a male-to-female ratio of approximately 1.5:1. September recorded the highest peak of infections at 16.0%, followed by April at 13.5%, indicating that the disease is predominantly concentrated during seasonal transition periods. Furthermore, the results revealed a marked concentration of infections in urban areas (the city), accounting for 57.8% of cases compared to 42.2% in rural areas, with a difference of 15.6 percentage points. The study concludes that the risk of contracting pneumonia decreases progressively with age, correlating with the increasing efficiency of the immune system. The data also confirm that males consistently outnumber females in infections across all age groups and throughout all months of the year. These findings necessitate strengthening preventive and diagnostic measures, particularly during the identified seasonal peak periods.

Keywords: Pneumonia, Children, Holy Karbala, Inflammatory Exudate.

Introduction

Pneumonia is one of the most prominent health challenges facing medical systems globally. It is an acute infection that affects the lung tissue, specifically the alveoli and bronchioles. Physiologically, this condition is characterized by an inflammatory response that leads to the alveoli filling with fluid and inflammatory exudate. This impairs the basic vital function of the lung, which is gas exchange, leading to

capillary and tissue hypoxia accompanied by acute respiratory pain (Torres et al., 2021; Dimitropoulos et al., 2024).

Despite the qualitative leaps achieved by medicine in the twentieth century with the appearance of antibiotics and vaccines, this disease still represents a massive economic and social burden. Classical medical literature, specifically physician William Osler, described pneumonia as the "Captain of the

Men of Death," a description that still resonates in modern statistics. Global Burden of Disease (GBD) studies indicate that lower respiratory tract infections are the leading cause of death from infectious diseases globally, and the fifth among all causes of death in general. *Streptococcus pneumoniae* bacteria emerge as a critical factor, causing 55% of respiratory deaths, with a rate reaching 1.5 million deaths annually (McAllister et al., 2019; Narciso, 2025)

The epidemiology of pneumonia takes a distinct U-shaped demographic curve, where the highest rates of infection and mortality are concentrated in children under the age of five and the elderly over the age of sixty-five. These epidemiologies are affected by complex environmental and biological determinants, including air pollution, smoking, and overcrowding, in addition to the immune status of the host, which plays a decisive role in the distribution and exacerbation of cases (Metlay et al., 2019; Musher and Thorner, 2014; Mandell and Niederman, 2019; Michelow, 2004; Lee and Chung, 2022).

The contemporary research problem lies in the complexity of diagnostic and therapeutic processes. Medical staff face challenges in distinguishing between bacterial, viral, and atypical causes, especially in light of the emergence of bacterial strains resistant to traditional antibiotics (García-García et al., 2012; Torres et al., 2017; Narciso, 2025). Furthermore, the gap between laboratory diagnosis and clinical practice in outpatient clinics complicates disease management, necessitating the update of preventive and therapeutic protocols based on the latest scientific evidence (Jones et al., 2026; Lee et al., 2022; Michelow et al., 2004). Pathogenic causes of pneumonia vary among bacterial, viral, and fungal origins (Torres et al., 2021; Tsolia, 2004; Drummond et al., 2000). *Streptococcus pneumoniae* bacteria are considered the primary culprit behind acute cases in adults (Musher and Thorner, 2014; Narciso, 2025), whereas viruses such as influenza and respiratory syncytial virus (RSV) dominate infections among children and the elderly (Jroundi et al., 2014; Xu et al., 2023). At the molecular level, these bacteria utilize complex mechanisms such as the "capsule", choline-binding proteins (Musher et al., 2022; Tsolia, 2004), and toxins like "pneumolysin" to evade the immune system and destroy lung cells (Menéndez et al., 2009; Wallihan and Ramilo, 2014). Furthermore, environmental conditions and the disruption of the normal microbial balance within the lung play an essential role in triggering infection, particularly in the presence of predisposing factors, such as prior

viral infections, which facilitate bacterial invasion and spread (Musher et al., 2022; Cutts, 2025).

Traditionally, clinical diagnosis relies heavily on presenting symptoms such as fever, cough, and dyspnea—which manifest in approximately 67–75% of cases alongside the CURB-65 scoring system to assess severity (Metlay et al., 2019; Jones et al., 2026; Musher and Thorner, 2014; Hansen, 2006). However, the year 2025 marked a significant revolution in the integration of Artificial Intelligence (AI) into respiratory medicine; research teams successfully developed models leveraging Convolutional Neural Networks (CNNs) capable of automating the detection of pulmonary infiltrates from chest X-ray images with exceptional accuracy, thereby reducing clinical workload and accelerating therapeutic interventions (Jones et al., 2026; Berild et al., 2020). Furthermore, the updated 2025 guidelines from the American Thoracic Society (ATS) have increasingly encouraged the clinical adoption of lung ultrasound as a highly reliable, safer, and radiation-free alternative diagnostic tool in specific clinical scenarios (Torres et al., 2017; Jartti, 2004).

Study Design and Data Collection: Work on this study began on February 1st 2026, at the Karbala Polytechnic College, Department of Community Health Technologies. This was facilitated through the mission facilitation letter addressed to the Karbala Health Directorate, Al-Hussein Medical Hospital, numbered 27/7/2277 on February 24th 2026, for the purpose of collecting data and information about pneumonia patients for the year 2025.

This study adopted an Analytical Descriptive Method to review and analyze the statistical records of pneumonia patients, aiming to understand the demographic and temporal patterns of the disease's spread. The methodological procedures are summarized as follows:

Study Sample: The study included a total sample of 905 pneumonia patients who were registered and classified based on specific medical diagnostic criteria.

Data Collection Tools: Data were collected relying on medical records and classified into statistical tables that included three primary variables.

Age: The sample was divided into four age groups (less than a year, 1–4 years, 5–9 years, 10–14 years)

Gender: Cases were classified into (males and females)

Time Factor: Tracking the distribution of infections over (12 months) from January to December

Statistical Analysis: The following statistical methods were used to analyze the extracted data using Microsoft Excel to design the tables

Frequencies: To calculate the total number of infected individuals in each category

Percentages: To determine the relative importance of each age group or gender compared to the total sum.

Results and Discussion

The results of the study for the year 2025 are illustrated in Figure (1) which shows the total number of pneumonia infections and illustrates the distribution of the total number of infected individuals according to age groups. It is evident that the age group (1–4 years) recorded the highest number of infections, reaching (378 cases) at a rate of (42%), indicating that this group is the most vulnerable to infection. This was followed by the category of less than one year with (246 cases) at a rate of (27%), then the group (5–9 years) with (153 cases) at a rate of (17%). Meanwhile, the group (10–14 years) recorded the lowest infection rate with (128 cases) at a rate of (14%).

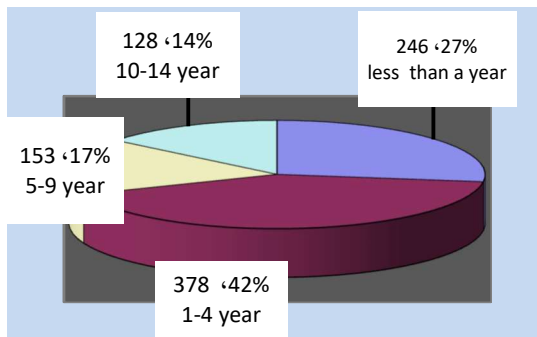


Figure (1): Total number of infected people.

Gender of Participants: Figure (2) illustrates the percentage of pneumonia patients for both genders, where the percentage of males reached 59.6% while the percentage of females reached 40.4% of the total sample.

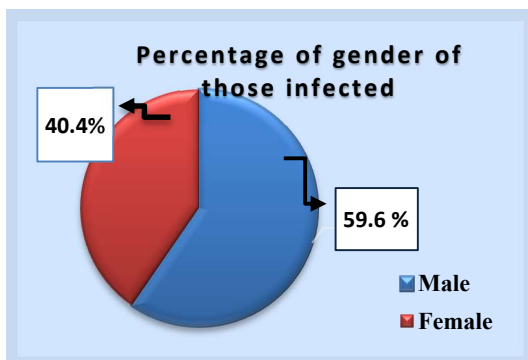


Figure (2): Gender of participants.

The total number and percentage of infected individuals according to age group for both males and females were shown in Table (1), the total number of infected individuals reached 905 cases. The number of males was higher than females; the number of males reached 539 cases (59.6%), while the number of females reached 366 cases (40.4%). As for the age groups, the highest infection rate was in the age group 1–4 years, where the number of infected individuals reached 378 cases, representing 41.78% of the total cases. This was followed by the category of less than one year with 246 cases (27.18%). Infections decreased in the older age groups: 5–9 years recorded 153 cases (16.9%), and the 10–14 years group recorded 128 cases (14.14%). The results also indicate that males were more affected than females across all age groups. The highest infection for males was in the age of 1–4 years with 220 cases (24.30%), and similarly, the highest infection for females was in the same age with 158 cases (17.45%). Table (2) clarifies the distribution of infections during the months of the year, at September recorded the highest number of infections with 148 cases (16%), followed by April with 123 cases (13.5%), and then March with 96 cases (10.6%). Meanwhile, the lowest infections were in October with 33 cases (3.6%), as well as in January and February with 36 cases each (3.9%). In general, the results indicate that infections are concentrated more among young children, especially in the age group 1–4 years, and that males are more vulnerable to infection than females. Additionally, there is a seasonal increase in infections during the spring and the beginning of autumn compared to the rest of the months of the year. Table (3) clarifies the numbers and percentages of disease infection during the months of the year according to gender, the total number of infected individuals reached (905) cases, with a high percentage of males (59.6%) compared to females (40.44%). Infections were concentrated in young ages, especially the (1–4 years) group which recorded the highest rate, followed by the category of less than one year, with a clear decrease in the older groups. Male infections were higher than females in all age groups. According to the months, September recorded the highest number of infections, while the lowest values were in October, January, and February.

Table (1): Total number and percentage of those infected according to age group for both males and females

Age Groups (year)	Number	Percentage %	Male	Percentage %	Female	Percentage %
Less than year	246	27.18	139	15.36	107	11.84
1-4	378	41.78	220	24.30	158	17.45
5-9	153	16.9	95	10.5	58	6.40
10-14	128	14.14	85	9.4	43	4.75
Total	905	100	539	59.6	366	40.4

Table (2): Numbers and percentage of pneumonia cases during the months of the year

Months of the Year	Number of infections	Percentage %
January	36	3.9
February	36	3.9
March	96	10.6
April	123	13.5
May	81	8.9
June	84	9.2
July	64	7
August	64	7
September	148	16
October	33	3.6
November	61	6.7
December	79	8.7
Total	905	100

Table (3): Numbers and percentage of infection with the disease during the months of the year by gender

Months	Infections	Percentage %	Males	Percentage %	Females	Percentage %
January	36	3.9	23	2.54	13	1.43
February	36	3.9	21	2.32	15	1.65
March	96	10.6	58	6.4	38	4.19
April	123	13.5	73	8.06	50	5.52
May	81	8.9	49	5.41	32	3.53
June	84	9.2	53	5.85	31	3.42
July	64	7	37	4.08	27	2.98
August	64	7	38	4.19	26	2.87
September	148	16	84	9.28	64	7
October	33	3.6	20	2.20	13	1.43
November	61	6.7	35	3.86	26	2.87
December	79	8.7	48	5.3	31	3.42
Total	905	100	539	59.6	366	40.4

Table (4) shows the infection of children with acute respiratory infections according to residential areas; the table indicate a relative disparity in the distribution of infections between the two environmental settings. Urban areas (the city) recorded the highest percentage at about 57.8% of the total cases, compared to 42.2% for rural areas.

Table (4): Incidence of acute respiratory infections among children according to residential areas

Residential Area	Number of infections	Percentage %
Rural	382	42.2
Urban (City)	523	57.8
Total	905	100

Pneumonia is considered one of the most dangerous acute respiratory diseases affecting the lungs. Fluids or pus gather in the air sacs (alveoli), making breathing painful and limiting the amount of oxygen that reaches the blood. The causes of this disease vary among bacteria, viruses, and fungi, making it a major health challenge, especially in developing countries (Menéndez et al., 2009; Dimitropoulos et al., 2024; Sahoo and Rout, 2025; Fletcher et al., 2014).

The results in Figure (1) showed that the age group (1–4 years) is the most vulnerable to pneumonia, recording the highest rate of 42% (378 cases). This is followed by children less than a year old at 27% (246 cases), then the group (5–9 years) at 17% (153 cases). Meanwhile, the older age group (10–14 years) recorded the lowest infection rate at 14% (128 cases). This distribution indicates that the risk of infection decreases gradually with the child's advancement in age and the increasing efficiency of their immune system, which agrees with (Htar et al., 2017; Fletcher et al., 2014; Gromelsky, 2025)

Figure (2), showed a clear disparity in the infection rate between the two genders; the percentage of males reached 59.6% of the total sample, while the percentage of females reached 40.44%. These results reflect that males in the study community are more vulnerable to pneumonia compared to females, with a ratio of approximately 1.5 to 1, which agrees with (Musher et al., 2022; Jartti, 2004; Narciso, 2025).

Table (1) provides a detailed breakdown of the total sample of 905 cases. The figures confirm that males (539 cases) numerically outperform females (366 cases) across all age groups without exception. The table shows that the peak of infections for males was at the age of (1–4 years) with 220 cases (24.30%), and similarly for females at the same age with 158 cases (17.45%). The table also numerically proves a significant decrease in the number of cases in the older age groups (10–14 years) for both genders, which agrees with, (Berild et al., 2020; Gromelsky, 2025; Huh, 2020).

Regarding Table (2), this table reviews the temporal distribution of infections. It was found that September recorded the highest peak of infections with 148 cases (16%), followed by April with 123 cases (13.5%). Conversely, the lowest levels of infection were recorded in October with 33 cases (3.6%). These results indicate a clear seasonal pattern, where infections are concentrated during seasonal transition periods (the beginning of autumn and the middle of spring), which agrees with (Htar et al., 2017; Ueda, 2024; Kassaw, 2023; Xu et al., 2021).

Table (3), concerning the numbers and percentages of infection according to the months of the year and gender, links the temporal factor (months) and the qualitative factor (gender). The data show that males recorded the highest infections in all months compared to females. For example, in the peak month (September), male infections reached 84 cases (9.28%) compared to 64 cases (7%) for females. The table also clarifies that the lowest number of infections for males was in October (20 cases), while females recorded the lowest number in January and October (13 cases each), which agrees with (Howroyd et al., 2025; Musher and Thorner, 2014; Hansen et al., 2006).

The data in Table (4) show a clear numerical and percentage superiority for infections in the city compared to the rural areas, where the city accounted for about 57.8% of the total infections (905 cases). This result reflects the concentration of health risks or incidents in urban environments, which is often attributed to high population density that increases the likelihood of infection or shared injuries. The difference of 15.6% between the two regions also indicates the presence of environmental or behavioral factors in cities (such as overcrowding, pollution, or a fast-paced lifestyle) that raise infection rates. From another perspective, these figures do not necessarily mean that rural areas are "safer" in an absolute sense; rather, they may indicate a gap in access to health services. Cities have more efficient monitoring and registration centers, making the registered cases appear larger and more accurate compared to rural areas, some of whose regions may lack documentation for all infections agree with (Seligman et al., 2012; Mandell and Niederman, 2019; Xu et al., 2021).

Conclusions

Critical Age Group: The primary conclusion is that children aged 1–4 years are the most vulnerable to pneumonia, accounting for 42% of total cases, which reflects relatively weak acquired immunity during this transitional stage of growth and immune system maturation.

Gender Disparities: The study demonstrated a clear disparity in favor of males, who constituted 59.6% of total infections - a pattern consistently observed in most respiratory infections among children.

Seasonal Pattern: Pneumonia infection is closely linked to weather fluctuations, with infection rates peaking in September (16.0%) and April (13.5%), which correspond to seasonal transition periods (autumn and spring) when microbial pathogens become more active.

Inverse Relationship with Age: The results reveal an inverse relationship between age and infection rates, as susceptibility decreases progressively with advancing age, with the 10–14 years age group recording the lowest infection level at 14.14%.

Geographical Distribution: The study demonstrated a significant disparity in the geographical distribution of pneumonia cases, with urban areas (the city) recording a higher incidence rate at 57.8% compared to 42.2% in rural areas, resulting in a difference of 15.6 percentage points. This concentration in urban environments highlights the potential impact of high population density and environmental determinants on transmission dynamics.

Recommendations

Seasonal Awareness Campaigns: The necessity of intensifying health awareness campaigns for parents prior to the onset of September and April, focusing on preventive measures against respiratory infections and the importance of avoiding sudden weather fluctuations.

Early Care and Prompt Consultation: Encouraging mothers to seek early consultation at primary healthcare centers as soon as initial respiratory symptoms appear in children aged 1–4 years, in order to prevent the development of pneumonia-related complications.

Future Research Directions: Recommending further studies to investigate the environmental and behavioral factors that may explain why September consistently records the highest infection rates, as well as exploring the immunological mechanisms underlying the higher susceptibility observed in males compared to females.

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