

# Meta-Analysis on Prevalence of Pediatric Community-Acquired Pneumonia in India

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Received: 10-01-2023 / Revised: 09-02-2023 / Accepted: 14-03-2023

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Conflict of interest: Nil

## Abstract

**Introduction:** A severe inflammation of the parenchymal tissue of the lungs is known as pneumonia. According to the location of acquisition, it can be categorized as community- or hospital-acquired; according to the etiological agents or mechanisms, it can be categorized as bacterial, viral, fungal, aspiration- or ventilator-associated; according to the involved lung anatomy, it can be categorized as lobar pneumonia, bronchial pneumonia, or acute interstitial; and according to the clinical severity, it can be categorized.

**Aims and Objective:** To determine the pooled prevalence of Community-Acquired Pneumonia (CAP) from the included studies.

**Methods:** The literature search was made by using MeSH keywords from ScienceDirect, Google Scholar, Cochrane library, PubMed, and Scopus. PRISMA diagram has been represented to show the steps of inclusion of studies. The statistical analysis has been done by MetaXL for the effective determination of pooled prevalence.

**Results:** The meta-analysis showed the detailed statistical findings of the included studies and  $p=.000$  implies that the pooled prevalence by Fixed Effect and Random Effects is significant in the population.

**Conclusion:** The meta-analysis has concluded that the prevalence of CAP among the pediatric population in India is significant and this finding would help clinicians to make an early diagnosis of CAP by effective tests for the suspected individuals.

**Keywords:** CAP, Pneumonia, Prevalence.

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## Introduction

Pneumonia is a severe inflammation of the lungs' parenchymal tissue. According to the place of acquisition, it can be classified as community- or hospital-acquired; according to the etiological agents or mechanisms, it can be classified as bacterial, viral, fungal, aspiration- or ventilator-associated; according to the lung

anatomy involved, it can be classified as lobar pneumonia, bronchial pneumonia, or acute interstitial; and according to the clinical severity, it can be classified as "no pneumonia," "pneumonia," or "very severe pneumonia [1-3].

Children under the age of five are more likely to develop pneumonia, which

continues to be the leading cause of morbidity and mortality in this age group [4]. A global estimate from 2000 states that pneumonia affects more than 156 million children under the age of five every year, 151 million of whom live in developing countries, and causes roughly 1.2 million fatalities. South-east Asia and Africa were the two continents with the highest frequency of pediatric pneumonia, with an estimated 61 million and 35 million cases of pneumonia in children under the age of five per year, respectively [5]. Pneumonia affected 102 million children under the age of five globally in 2015, down from 120 million in 2010 (with 0.88 million deaths). These decreases were a result of a lessening of the severity of the primary risk factors, enhanced socioeconomic development and preventive measures, improved access to care, and higher hospital care standards. Despite these developments, pneumonia remains a significant public health issue for children, particularly in developing countries [4].

Numerous investigations have been conducted across the globe to identify pneumonia risk factors. Despite the conflicting findings, low birth weight, malnutrition, indoor air pollution, parental smoking, lack of immunizations, crowding, a shared kitchen, not exclusively breastfeeding, and maternal education were discovered to be risk factors for pneumonia in children under the age of five [6–9].

Community-acquired pneumonia (CAP) is a common infectious disease throughout the world. The illness has a significant impact on healthcare in poor countries like India. India alone is responsible for around one-fourth of the global burden of pneumonia, with a case fatality rate (CFR) of 14%–30% [10]. Due to the significant effects that comorbidities and risk factors have on the incidence, complications, mortality, and management of CAP [11], clinicians face significant challenges. A European study found that the incidence of CAP is increased by two to four times by

concurrent diseases such as dementia, cerebrovascular disease, HIV, chronic renal and liver disease, and chronic respiratory and cardiovascular problems. Alcoholism and smoking were also identified as common risk factors for the disease in the same analysis [11].

Similar investigations out in the US identified ageing as a common risk factor for increased incidence and related death [12,13]. In India, the concomitant illnesses and risk factors connected to a higher risk of CAP are not well-known. Although a few studies have reported these findings, the evidence is scattered, and there isn't a complete study accessible right now. Before our study, the risk factors and concomitant diseases that increase the risk of CAP in the Indian population had never been in-depth evaluated and analyzed. The results of this study would help physicians implement particular risk-reduction measures to minimize the burden of CAP disease on the country.

## Methods

### Search Strategy

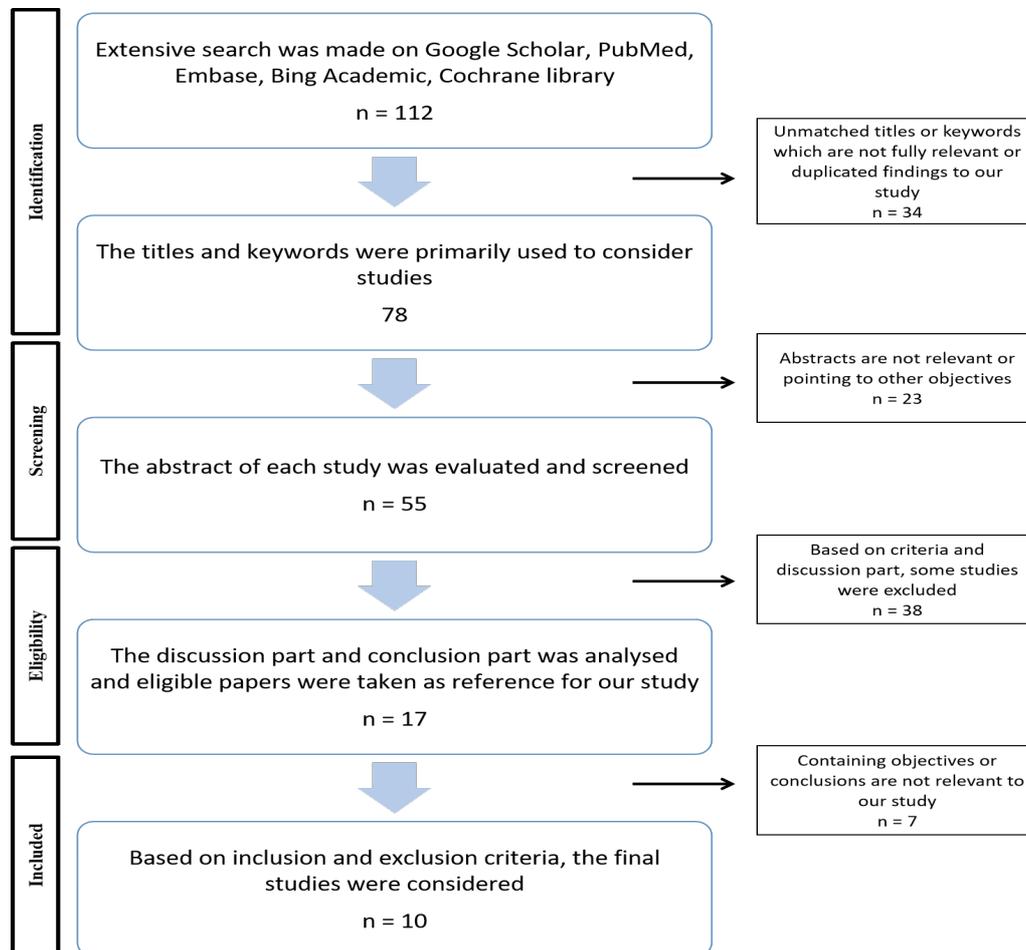
The literature search was made by using MeSH keywords from ScienceDirect, Google Scholar, Cochrane library, PubMed, and Scopus. The search terms used included ((Prevalence) AND (Pediatric OR Children) AND (Community Acquired OR Community) AND (Pneumonia OR Lung Infection)). An Independent search was made by using the combination of terms (Prevalence AND (CAP OR Community-Acquired Pneumonia OR Pneumonia)). The search was made from 2005 to 2023 on the prevalence of CAP in pediatric population.

### Data Extraction

The study found 10 eligible studies for final inclusion. The search was made and likely studies were sorted. The unmatched titles, unmatched keywords and duplicated studies were excluded to obtain 78 studies. Irrelevant abstracts and studies with

unmatched objectives were excluded. Based on the discussion and conclusion, this meta-analysis finally included 10 studies and they are summarized in Table 1.

Figure 1 shows the PRISMA diagram of the inclusion steps.



**Figure 1: PRISMA diagram of this meta-analysis**

### Inclusion and Exclusion Criteria

This meta-analysis included those studies that are being conducted in India with the Indian population between 2005 and 2023 on the pediatric population. Studies including suspected individuals with pneumonia were considered for this analysis.

The studies which contain the non-Indian population or adult population were excluded. Again, the studies on pediatric pneumonia prevalence which covered types of pneumonia other than community-acquired were also excluded.

### Statistical Analysis

This analysis used MetaXL for effective analysis. It was done both by using Fixed Effects and Random Effects. Funnel plot and statistical findings were calculated using MetaXL.  $I^2$ , Cochran's Q and  $X^2$  with p-value were also determined.

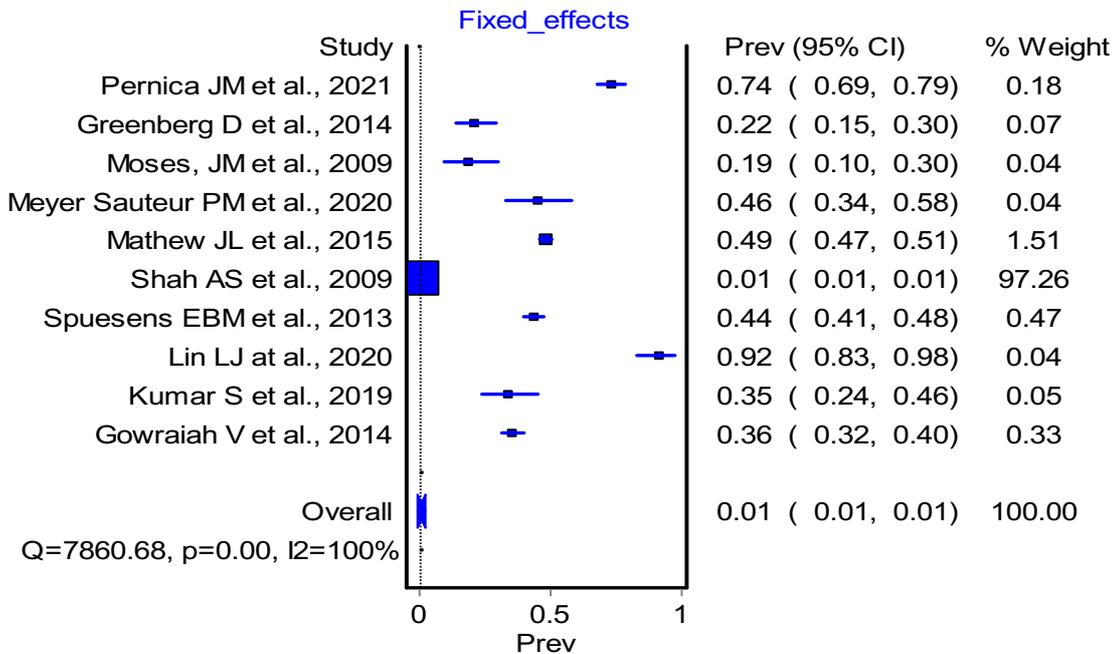
### Results

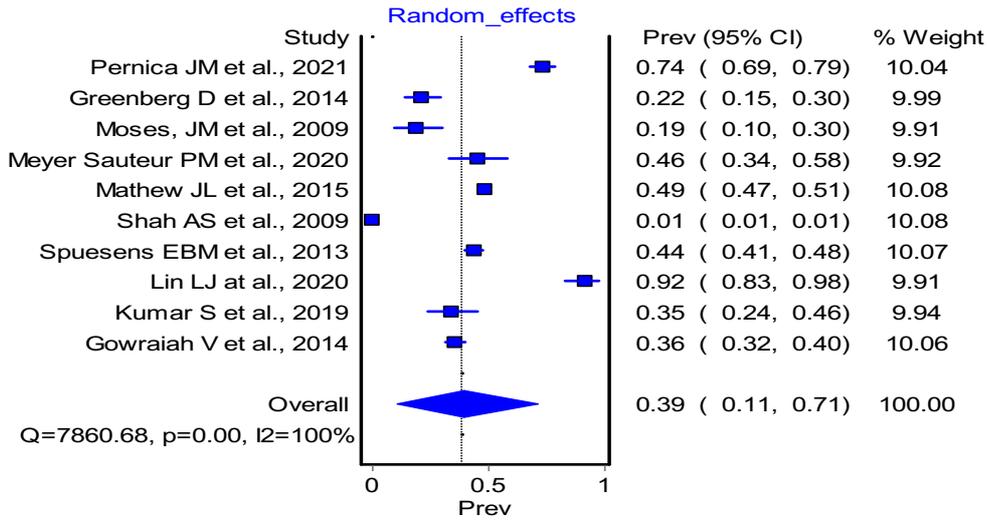
The meta-analysis has listed the included studies in Table 1 with number of subjects and their respective CAP patients.

**Table 1: The final studies that are included in this meta-analysis**

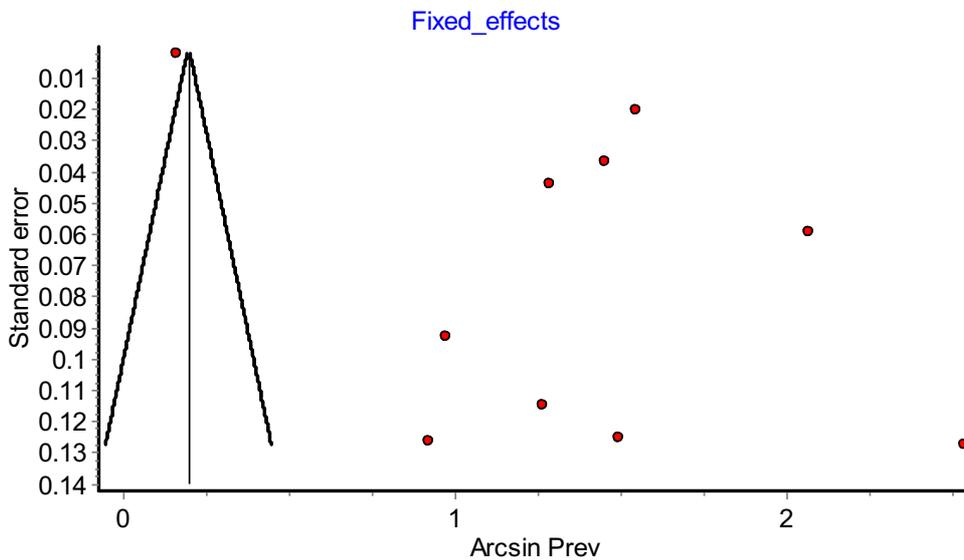
Name of the authors	Type of study	Age	Number of Patients	Patients with CAP	Percentage
Pernica JM et al., 2021 [14]	Prospective Study	< 5 years	281	208	74.02
Greenberg D et al., 2014 [15]	RCT	< 5 years	115	25	21.74
Moses, JM et al., 2009 [16]	Retrospective	5.5 months to 20 years	62	12	19.35
Meyer Sauter PM et al., 2020 [17]	Prospective Cohort	3 years to 18 years	63	29	46.03
Mathew JL et al., 2015 [18]	Prospective study	< 12 months	2345	1145	48.83
Shah AS et al., 2009 [19]	Retrospective	< 5years	150,945	967	0.64
Spuesens EBM et al., 2013 [20]	Prospective study	3 months to 16 years	726	321	44.21
Lin LJ at al., 2020 [21]	Prospective study	< 5 years	61	56	91.80
Kumar S et al., 2019 [22]	Prospective study	1 month to 5 years	75	26	34.67
Gowraiah V et al., 2014 [23]	Prospective observational study	< 5 year	516	185	35.85

Figure 2 and Figure 3 respectively show the funnel plots of the included studies.





**Figure 2: Forest Plot of the included studies. (Above) The forest plot with fixed effect (Below) the forest plot with Random effect**



**Figure 3: Funnel Plot of the included studies**

Table 2 and Table 3 show the detailed statistical findings of the included studies and  $p=0.000$  implies that the pooled prevalence by Fixed Effect (Table 2) and Random Effects (Table 3) is significant in the population.

**Table 2: Main statistical findings of the study (Fixed Effect)**

Study	Prevalence	LCI 95%	HCI 95%	weight (%)
Pernica JM et al., 2021 [14]	0.740213523 131673	0.68722936 5267613	0.78992015679 8124	0.18138587832 0038
Greenberg D et al., 2014 [15]	0.217391304 347826	0.14634302 2655727	0.29783810223 5736	0.07442298026 98558
Moses, JM et al., 2009 [16]	0.193548387 096774	0.10360710 667629	0.30234141987 4906	0.04027217547 07012
Meyer Sauteur PM et al., 2020 [17]	0.460317460 31746	0.33825133 6627928	0.58478328892 4308	0.04091653027 82324

Mathew JL et al., 2015 [18]	0.488272921 108742	0.46805011 8640595	0.50851492969 9144	1.51133420106 447
Shah AS et al., 2009 [19]	0.006406306 93298884	0.00601000 293653348	0.00681517254 593728	97.2624586002 036
Spuesens EBM et al., 2013 [20]	0.442148760 330579	0.40616936 8973588	0.47843402340 5664	0.46812376767 1431
Lin LJ at al., 2020 [21]	0.918032786 885246	0.83367435 7978926	0.97605364882 475	0.03962782066 317
Kumar S et al., 2019 [22]	0.346666666 666667	0.24258338 4534425	0.45854934469 9055	0.04864878796 8607
Gowraiah V et al., 2014 [23]	0.358527131 782946	0.31765925 8495953	0.40044709557 1728	0.33280925808 9875
Pooled	0.009712676 40846202	0.00923073 109698858	0.01020675759 4006	100
<b>Statistics</b>				
<b>I<sup>2</sup></b>	99.88550609 97628	99.8722615 912419	99.8973773564 351	
<b>Cochran's Q</b>	7860.680771 0753			
<b>X<sup>2</sup>, p</b>	0.000			

**Table 3: Main statistical findings of the study (Random Effect)**

Study	Prevalence	LCI 95%	HCI 95%	weight (%)
Pernica JM et al., 2021 [14]	0.74021352313 1673	0.6872293652 67613	0.789920156 798124	10.04361709 95102
Greenberg D et al., 2014 [15]	0.21739130434 7826	0.1463430226 55727	0.297838102 235736	9.989649197 11485
Moses, JM et al., 2009 [16]	0.19354838709 6774	0.1036071066 7629	0.302341419 874906	9.913050939 25095
Meyer Sauter PM et al., 2020 [17]	0.46031746031 746	0.3382513366 27928	0.584783288 924308	9.915660231 23996
Mathew JL et al., 2015 [18]	0.48827292110 8742	0.4680501186 40595	0.508514929 699144	10.07694918 76371
Shah AS et al., 2009 [19]	0.00640630693 298884	0.0060100029 3653348	0.006815172 54593728	10.08144142 14276
Spuesens EBM et al., 2013 [20]	0.44214876033 0579	0.4061693689 73588	0.478434023 405664	10.06679503 85235
Lin LJ at al., 2020 [21]	0.91803278688 5246	0.8336743579 78926	0.976053648 82475	9.910358232 8241
Kumar S et al., 2019 [22]	0.34666666666 6667	0.2425833845 34425	0.458549344 699055	9.941655143 08901
Gowraiah V et al., 2014 [23]	0.35852713178 2946	0.3176592584 95953	0.400447095 571728	10.06082350 93828
Pooled	0.39110440803 5191	0.1085143958 9669	0.713645854 373798	100
<b>Statistics</b>				
<b>I<sup>2</sup></b>	99.8855060997628	99.8722615912419	99.8973773564351	
<b>Cochran's Q</b>	7860.6807710753			
<b>X<sup>2</sup>, p</b>	0.000			

## Discussion

The incidence, mortality, complications, and management of community-acquired pneumonia problems and treatment results are significantly impacted by comorbidities and risk factors. A study uses a systematic review and meta-analysis to try to find the same in the Indian population. According to the study's findings, the Indian population was particularly vulnerable to community-acquired pneumonia due to comorbid illnesses like hypertension, chronic obstructive pulmonary disease, and diabetes mellitus as well as variables like advanced age and a history of smoking [19-22].

An acute inflammation of the parenchymal tissue of the lungs is known as pneumonia. It is a significant issue for public health and the main cause of sickness and mortality in children under five, particularly in underdeveloped nations. According to estimates, there were 102 million episodes of pneumonia in children under the age of five in 2015, and 0.7 million of those instances resulted in fatalities. Pneumonia's prevalence in Eastern Africa was revealed by many primary investigations [20]. However, there was a discrepancy between those investigations, and no study was done to report the combined magnitude and related factors. To determine the national prevalence of pneumonia and its contributing factors in Eastern Africa, a review was conducted. According to the report, pneumonia is still widely prevalent in Eastern Africa. Policymakers and program managers will benefit from the review as they develop strategies to avoid pneumonia [22].

Approximately two million children under the age of five die from pneumonia each year, accounting for approximately one in five child fatalities worldwide. To accomplish MDG4 in poor countries, it is essential to pinpoint its prevalence in children under the age of five and the contributing variables [23]. An earlier study's major goal was to determine the

prevalence and risk factors for pneumonia in children under the age of five in Este town and the nearby rural kebeles in northwest Ethiopia. Pneumonia prevalence in children under the age of five over the past two weeks was 16.6% overall. The most significant factors related to pneumonia in children under five were stunting, living in a crowded house, carrying the child on the back while cooking, using charcoal for cooking, and having cattle inside the main home according to the study. According to the study, pneumonia was common among children under five in the study area [24].

One-third of the overall WHO South East Asia burden of under-five mortality is borne by India. Epidemiological studies revealing the true burden of pneumonia are few and far between. The ability to successfully design and implement preventative actions for pneumonia reduction will be aided by the identification of the risk factors connected with the disease [25]. The findings of a study revealed that it was linked to partial immunization rather than any of the home environment characteristics. Mothers were found to have poor feeding habits, poor knowledge of the signs and symptoms of pneumonia, and poor hand hygiene. According to the study's findings, Maharashtra's Pune and Sangli districts had exceptionally low rates of pneumonia. The most significant risk factor was discovered to be partial vaccination. A higher literacy rate among mothers and higher immunization coverage may be contributing reasons to the low incidence of pneumonia and its lack of connection with established risk factors [26].

To determine the prevalence of community-acquired pneumonia (CAP) in children (2-59 months) in four areas of Northern India, a prospective study was conducted. According to the study's findings, CAP incidence was nearly five to 10 times greater in newborns (2-11 months) than in people aged 12-59 months.

According to the report, there is a high frequency of CAP in Uttar Pradesh and Bihar, with newborn rates being significantly higher. Therefore, it is necessary to implement preventative measures, enhance health-seeking behaviour, and improve the standard of care for CAP [27-30].

### Conclusion

The meta-analysis has concluded that the prevalence of CAP among the pediatric population in India is significant and this finding would help clinicians to make an early diagnosis of CAP by effective tests for the suspected individuals. This meta-analysis showed a very specific prevalence among the Indian pediatric population. Although this meta-analysis has included a smaller number of studies, the specification of each study met the eligibility criteria, due to which, the specific finding and conclusion could be obtained. However, it can be highlighted that there is a lack of original studies on CAP among the Indian pediatric population. The authors suggest conducting more survey-based studies all over India to bring out the larger picture of CAP prevalence in the varied population. However, this meta-analysis has successfully highlighted the detailed statistical metrics of CAP and the epidemiological status of CAP in India among the pediatric population suggesting we conduct more studies on management in coming years.

### References

1. Mackenzie G. The definition and classification of pneumonia. *Pneumonia*. 2016;8(1):14.
2. WHO. Revised WHO classification and treatment of childhood pneumonia at health facilities. WHO. 2014.
3. Kalil AC, Metersky ML, Klompas M, Muscedere J, Sweeney DA, Palmer LB, et al. Management of adults with hospital-acquired and ventilator-associated pneumonia: 2016 clinical practice guidelines by the Infectious Diseases Society of America and the American Thoracic Society. *Clin Infect Dis*. 2016;63(5):e61–e111.
4. McAllister DA, Liu L, Shi T, Chu Y, Reed C, Burrows J, et al. Global, regional, and national estimates of pneumonia morbidity and mortality in children younger than 5 years between 2000 and 2015: a systematic analysis. *Lancet Glob Health*. 2019;7(1):e47–57.
5. Rudan I, Boschi-Pinto C, Biloglav Z, Mulholland K, Campbell H. Epidemiology and etiology of childhood pneumonia. *Bull World Health Organ*. 2008;86: 408–16B.
6. Ramezani M, Aemmi SZ, Emami MZ. Factors affecting the rate of pediatric pneumonia in developing countries: a review and literature study. *Int J Pediatr*. 2015;3(6.2):1173–81.
7. Hemagiri K, Sameena A, Aravind K, Khan W, Vasanta S. Risk factors for severe pneumonia in under five children-a hospital-based study. *Int J Res Health Sci*. 2014;2(1):47–57.
8. Htar MTT, Stuurman AL, Ferreira G, Alicino C, Bollaerts K, Paganino C, et al. Effectiveness of pneumococcal vaccines in preventing pneumonia in adults, a systematic review and meta-analyses of observational studies. *PloS One*. 2017;12(5).
9. Nirmolia N, Mahanta TG, Boruah M, Rasaily R, Kotoky RP, Bora R. Prevalence and risk factors of pneumonia in under five children living in slums of Dibrugarh town. *Clin Epidemiol Glob Health*. 2018; 6 (1):1–4.
10. Eshwara VK, Mukhopadhyay C and Rello J. Community acquired bacterial pneumonia in adults: an update. *Indian J Med Res* 2020; 151(4): 287–302.
11. Torres A, Peetermans WE, Viegi G, et al. Risk factors for community-acquired pneumonia in adults in Europe: a literature review. *Thorax*. 2013; 68(11): 1057–1065.
12. Jackson ML, Neuzil KM, Thompson WW, et al. The burden of community-

- acquired pneumonia in seniors: results of a population-based study. *Clin Infect Dis.* 2004; 39(11): 1642–1650.
13. Buzzo AR, Roberts C, Mollinedo LG, et al. Morbidity and mortality of pneumonia in adults in six Latin American countries. *Int J Infect Dis.* 2013; 17(9): e673–e677.
  14. Pernica JM, Harman S, Kam AJ, Carciumaru R, Vanniyasingam T, Crawford T, Dagleish D, Khan S, Slinger RS, Fulford M, Main C, Smieja M, Thabane L, Loeb M. Short-Course Antimicrobial Therapy for Pediatric Community-Acquired Pneumonia: The SAFER Randomized Clinical Trial. *JAMA Pediatr.* 2021 May 1;175 (5): 475-482.
  15. Greenberg D, Givon-Lavi N, Sadaka Y, Ben-Shimol S, Bar-Ziv J, Dagan R. Short-course antibiotic treatment for community-acquired alveolar pneumonia in ambulatory children: a double-blind, randomized, placebo-controlled trial. *Pediatr Infect Dis J.* 2014 Feb;33(2):136-42.
  16. Moses, J. M., Alexander, J. L., & Agus, M. S. The correlation and level of agreement between end-tidal and blood gas pCO<sub>2</sub> in children with respiratory distress: a retrospective analysis - *BMC Pediatrics.* BioMed Central. 2009, March 12; <https://doi.org/10.1186/1471-2431-9-20>.
  17. Meyer Sauter PM, Krautter S, Ambroggio L, Seiler M, Paioni P, Rely C, Capaul R, Kellenberger C, Haas T, Gysin C, Bachmann LM, van Rossum AMC, Berger C. Improved Diagnostics Help to Identify Clinical Features and Biomarkers That Predict Mycoplasma pneumoniae Community-acquired Pneumonia in Children. *Clin Infect Dis.* 2020 Oct 23;71(7):1645-1654.
  18. Mathew JL, Singhi S, Ray P, Hagel E, Saghafian-Hedengren S, Bansal A, Ygberg S, Sodhi KS, Kumar BV, Nilsson A. Etiology of community acquired pneumonia among children in India: prospective, cohort study. *J Glob Health.* 2015 Dec;5(2):050418.
  19. Shah AS, Nisarga R, Ravi Kumar KL, Hubler R, Herrera G, Kilgore PE. Establishment of population-based surveillance for invasive pneumococcal disease in Bangalore, India. *Indian J Med Sci.* 2009 Nov;63(11):498-507.
  20. Spuesens EBM, Fraaij PLA, Visser EG, Hoogenboezem T, Hop WCJ, et al. Carriage of Mycoplasma pneumoniae in the Upper Respiratory Tract of Symptomatic and Asymptomatic Children: An Observational Study. *PLoS Med.* 2013; 10(5): e1001444.
  21. Lin LJ, Chang FC, Chi H, Jim WT, Tsung-Ning Huang D, Kung YH, Huang CY, Chiu NC, Chang L. The diagnostic value of serological studies in pediatric patients with acute Mycoplasma pneumoniae infection. *J Microbiol Immunol Infect.* 2020 Apr;53(2):351-356.
  22. Kumar S, Chakravarti A, Kumar S, Kapoor S. Detection of respiratory syncytial virus & Mycoplasma pneumoniae in paediatric lower respiratory tract infections. *Indian J Med Res.* 2019 Sep;150(3):306-309.
  23. Gowraiah V, Awasthi S, Kapoor R, et al. Can we distinguish pneumonia from wheezy diseases in tachypnoeic children under low-resource conditions? A prospective observational study in four Indian hospitals. *Archives of Disease in Childhood.* 2014; 99:899-906.
  24. Ghia, C. J., & Rambhad, G. S. Systematic review and meta-analysis of comorbidities and associated risk factors in Indian patients of community-acquired pneumonia. *SAGE Open Medicine,* 2022; 10: 20503121 221095485.
  25. Beletew B., Bimerew M., Mengesha A., Wudu M., & Azmeraw M. Prevalence of pneumonia and its associated factors among under-five children in East Africa: a systematic review and meta-

- analysis. *BMC paediatrics*, 2020;20(1): 1-13.
26. Abeje Fekadu G. Prevalence of Pneumonia among under-five Children in Este Town and the Surrounding Rural Kebeles, Northwest Ethiopia; A Community Based Cross Sectional Study. *Science Journal of Public Health*, 2014; 2(3): 150.
27. Gothankar J., Doke P., Dhumale G., Pore P., Lalwani S., Quraishi S., Murarkar S., Patil R., Waghachavare V., Dhobale R., Rasote, K., Palkar S., & Malshe N. Reported incidence and risk factors of childhood pneumonia in India: a community-based cross-sectional study. *BMC Public Health*, 2018;18(1).
28. Awasthi S., Pandey C. M., Verma T., Mishra N., & Group L. C. Incidence of community-acquired pneumonia in children aged 2-59 months of age in Uttar Pradesh and Bihar, India, in 2016: An indirect estimation. *PLoS ONE*, 2018;14(3).
29. Yadav S. ., Gupta D. K., Patil P. H., Tiwari A., & Soni P. To Study the Pharmacotherapy of Diabetes Mellitus Type 2 Patient in Echo Health Care & Research Centre, Indore". *Journal of Medical Research and Health Sciences*, 2023;6(2): 2389–2397.