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## Residential risk factors for childhood pneumonia: A cross-sectional study in eight cities of China



Yang Zhuge<sup>a</sup>, Hua Qian<sup>a,\*</sup>, Xiaohong Zheng<sup>a</sup>, Chen Huang<sup>b</sup>, Yiping Zhang<sup>c</sup>, Min Zhang<sup>a</sup>, Baizhan Li<sup>d</sup>, Zhuohui Zhao<sup>e</sup>, Qihong Deng<sup>f</sup>, Xu Yang<sup>g</sup>, Yuexia Sun<sup>h</sup>, Tingting Wang<sup>i</sup>, Xin Zhang<sup>j</sup>, Jan Sundell<sup>c</sup>

<sup>a</sup> School of Energy and Environment, Southeast University, Nanjing, China

<sup>b</sup> School of Environment and Architecture, University of Shanghai for Science and Technology, Shanghai, China

<sup>c</sup> Beijing Key Lab of Indoor Air Quality Evaluation and Control, Tsinghua University, Beijing, China

<sup>d</sup> Key Laboratory of Three Gorges Reservoir Region's Eco-Environment, Chongqing University, Chongqing, China

<sup>e</sup> School of Public Health, Fudan University, Shanghai, China

<sup>f</sup> School of Energy Science and Engineering, Central South University, Changsha, Hunan, China

<sup>g</sup> College of Life Science, Central China Normal University, Wuhan, China

<sup>h</sup> School of Environmental Science and Engineering, Tianjin University, Tianjin, China

<sup>i</sup> School of Public Health, Xinjiang Medical University, Urumqi, China

<sup>j</sup> Institute of Environmental Science, Shanxi University, Taiyuan, China

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### ABSTRACT

**Background:** Children's pneumonia is a heavy health burden. Few studies have been carried out on residential risk factors for pneumonia in children. Potential risks associated with dwelling characteristics are still unknown. **Methods:** A cross-sectional study was conducted among children in 8 cities in China during 2010–2011 and 41,176 valid data on children aged 3–8 years old were used in this analysis. To obtain the lifetime-ever incidence of pneumonia in children and identify associations between pneumonia and residential risk factors, *chi*-square analysis and logistic regression methods were employed. Adjusted odds ratios were used as measures of effect with a 95% confidence interval. Confounding variables in the regression model include children's gender, birthweight, breastfeeding duration, parental smoking and family history of atopy.

**Results:** The average lifetime-ever incidence of childhood pneumonia was 32.3%. Urban children (33.6%) had more pneumonia than suburban (29.9%) and rural children (24.9%). More residential risk factors were found in urban-dwellings. Boys, low birthweight (< 2500 g), breastfeeding duration < 6 months, family allergic history, and exposure to parental smoking were found to be associated with higher pneumonia lifetime-ever incidences. Various indicators of dampness, including visible mold spots, damp stains, water damage, water condensation, damp clothing or bedding and mold odor, were also positively associated with pneumonia. Pneumonia incidence increased as the number of dampness indicators increased. Both natural gas and solid cooking fuels were positively associated with pneumonia compared with electricity. Compared with cement, construction materials including synthetic fiber, laminated wood, real wood, paint, emulsion paint and wall paper were positively associated with pneumonia. Daily living habits such as putting bedding to sunshine frequently and cleaning the child's bedroom every day could be effective preventive strategies. A dose-response relationship between the number of residential risk factors and pneumonia was observed when the risk factors number ranged from 7 to 11. Residences with more risk factors had higher lifetime-ever pneumonia odds ratios.

**Conclusions:** Indoor environmental factors including dampness, use of solid fuels or natural gas for cooking and use of new construction materials are risk factors for childhood pneumonia. This study gives evidence for the importance of home environment exposures in the occurrence of childhood pneumonia. Actions against the residential risk factors described in this study may help to prevent pneumonia in children.

\* Corresponding author.

E-mail address: [qianh@seu.edu.cn](mailto:qianh@seu.edu.cn) (H. Qian).

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## 1. Introduction

Pneumonia is a lower respiratory infection caused by various infectious agents, including viruses, bacteria and fungi (Wardlaw et al., 2006). Pneumonia was the leading infectious cause of mortality in children under 5 years old in 2015 worldwide (WHO, n.d.). Southeast Asia and Africa have the highest morbidity and mortality for childhood pneumonia, with > 75% of pneumonia-related deaths occurring in Cambodia, China, Laos, Papua New Guinea, the Philippines and Vietnam (WHO, n.d.). A 2008 global review reported that Chinese children under 5 years old had an estimated 0.22 episodes per person-year, which is second only to India in burden (Rudan et al., 2013). A systematic review of literature during 1985–2008 on pneumonia incidence for children under 5 years old in mainland China reported that the incidence ranged from 0.06–0.27 episodes per person-year and varied widely among regions (Guan et al., 2010).

Efforts in reducing the morbidity and mortality of childhood pneumonia have focused on increasing vaccine coverage and reducing known risk factors (Nguyen et al., 2017). Malnourished children are exposed to higher risks of developing pneumonia, particularly those who have inadequate exclusive breastfeeding (Wardlaw et al., 2006). Exclusive breastfeeding during the first 6 months of life has been recognized as an effective way to prevent respiratory illness (Kramer and Kakuma, 2002). Immunization with “Haemophilus influenzae type B” (Hib) and “Pneumococcal conjugate vaccines” (PCV) would likely reduce pneumonia incidence (Qu et al., 2017).

It is acknowledged that childhood pneumonia is associated with environmental factors (WHO, n.d.). As the major indoor environment

for children, the residential environment plays an important role in increasing children's risk of developing pneumonias (Wang et al., 2013; Zheng et al., 2013). Identified pneumonia-related residential risk factors include crowding, exposure to parental smoking and indoor air pollution caused by cooking or heating with biomass fuels (Nguyen et al., 2017; Wardlaw et al., 2006). Several studies have revealed adverse effects of ETS (environmental tobacco smoke) on pneumonia in children, mainly in developing countries (Singh, 2005; Suzuki et al., 2009). Smoke caused by cooking and heating with biomass fuels has been reported to increase children's risk of pneumonia (Dherani et al., 2008; Mathew et al., 2011). Using gas stoves for heating without ventilation was found to be associated with higher odds of pneumonia among American children < 5 years old (Coker et al., 2015). Moreover, a strong positive correlation with a dose-response relationship between residential dampness-related indicators and pneumonia has been demonstrated by the CCHH study in Shanghai (Huang et al., 2014). Indoor residential chemical sources, including recent painting or renovation, new furniture and modern materials, have also been reported to be associated with respiratory symptoms and pneumonia in children (Wang et al., 2013; Zheng et al., 2013).

However, very little research has been conducted on relationships between childhood pneumonia and residential environmental factors in China, even though pneumonia is a heavy burden in China. This study focuses on residential risk factors associated with childhood pneumonia. Indoor environmental factors, including cooking fuel, cigarette smoke exposure, dampness, chemical emissions related construction materials and activities, are investigated. Differences in lifetime-ever incidence of pneumonia and significant risk factors are compared among urban, suburban and rural areas.

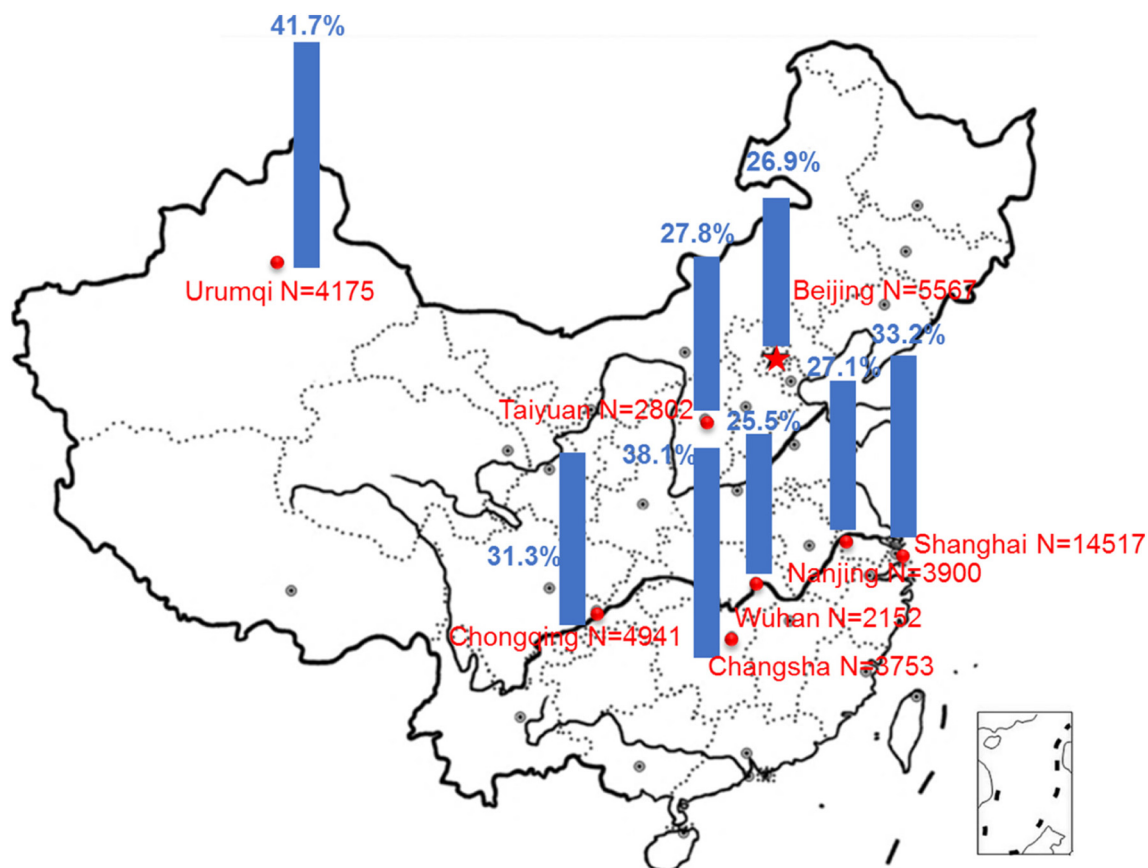


Fig. 1. Map of sample sizes and lifetime-ever incidences of pneumonia in eight Chinese cities.

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