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Household secondhand smoke exposure and recurrent acute respiratory infection among young children

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Abstract

Background: Acute respiratory infection (ARI) is common among young children, whose respiratory and immune defense mechanisms are still maturing. Household secondhand smoke exposure may increase susceptibility to recurrent respiratory infection by impairing mucociliary clearance and airway defense.
Purpose: To examine the association between household secondhand smoke exposure and recurrent ARI among children aged 1–5 years.
Method: This analytical observational study used a cross-sectional design and involved 93 children aged 1–5 years attending Balai Agung Community Health Centre, who were selected through purposive sampling. Household secondhand smoke exposure and recurrent ARI were assessed using a caregiver-completed questionnaire. Data were analyzed using the Pearson chi-square test, with statistical significance set at $p < 0.05$.
Results: Of the 93 children, 56 (60.2%) were classified as having low household secondhand smoke exposure and 37 (39.8%) as having moderate exposure, and recurrent ARI was reported in 69 children (74.2%). Recurrent ARI occurred in 32 of the 37 children with moderate exposure (86.5%) and in 37 of the 56 children with low exposure (66.1%). Household secondhand smoke exposure was significantly associated with recurrent ARI ($p = 0.028$).
Conclusion: Household secondhand smoke exposure was significantly associated with recurrent ARI among children aged 1–5 years. Because the study used a cross-sectional design, this finding should be interpreted as an association rather than as evidence of causation.

Keywords: Acute Respiratory Infection; Children Under Five; Passive Smoking; Secondhand Smoke.

INTRODUCTION

Acute respiratory infection (ARI) is common among children under five years of age and remains an important public-health concern. Young children are particularly susceptible because innate and adaptive immune responses continue to mature throughout early childhood, which influences their response to respiratory pathogens (Verhoeven, 2019). At the population level, secondhand smoke remains a measurable contributor to the burden of lower respiratory infection among children under five (Xiang, Chen, Dai, & Wang, 2023), and reviews consistently link environmental tobacco smoke exposure with acute and chronic respiratory morbidity in children (Vanker, Gie, & Zar, 2017).

Household secondhand smoke exposure is a potentially modifiable environmental factor. Children may inhale smoke produced by parents or other household members and generally have little control over their exposure at home. Tobacco smoke can increase oxidative stress and airway inflammation, alter epithelial and immune responses, increase mucus production, and impair mucociliary clearance (Strzelak, Ratajczak, Adamiec, & Feleszko, 2018). Biomarker studies further indicate that reported household exposure may underestimate actual exposure. Living with a parent who smokes predicts

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tobacco-specific toxicant exposure (Park, 2020), and urinary cotinine has identified secondhand smoke exposure in hospitalized young children even when caregivers did not report exposure (Stallings, Zhu, Grijalva, Edwards, Self, & Williams, 2021).

Previous evidence supports an association between secondhand smoke and respiratory morbidity in children. A nationally representative study of children aged 0–59 months reported higher odds of ARI among children exposed to household secondhand smoke, even in households using clean cooking fuel (Singh, Sinha, Singh, Singh, & Singh, 2022). A large multicity study also linked indoor tobacco smoke exposure with pneumonia, frequent common colds, cough, and croup (Zhuge, Qian, Zheng, Huang, Zhang, Li, Zhao, Deng, Yang, Sun, Zhang, & Sundell, 2020). Indonesian studies have similarly reported associations between household smoking and ARI in young children (Sutrisminah, Umroh, Hartati, & Safitri, 2026; Masrel, Syahda, & Alini, 2024). Broader systematic evidence links passive smoke exposure with lower respiratory infections, wheeze, asthma, and impaired respiratory health (Jayes, Haslam, Gratziou, Powell, Britton, Vardavas, Jimenez-Ruiz, & Leonardi-Bee, 2016; He, Wu, Zhang, Lin, Li, Xie, Li, Sun, Huang, Zhang, & Ming, 2020).

This study therefore aimed to examine the association between household secondhand smoke exposure and recurrent ARI among children aged 1–5 years attending Balai Agung Community Health Centre.

RESEARCH METHOD

This analytical observational study used a cross-sectional design and was conducted at Balai Agung Community Health Centre. The study population comprised children aged 1–5 years attending the health centre, and a total of 93 children were selected through purposive sampling according to the study criteria.

The independent variable was household secondhand smoke exposure, and the dependent variable was recurrent ARI. Data were collected using a questionnaire completed by the child's parent or caregiver. Exposure was classified as low (1–2 times per month), moderate (more than 3 times per week), or high (more than 7 times per week). Objective exposure measures such as urinary cotinine have been used in young children to complement caregiver-reported exposure (İnci, Uğur Baysal, & Şişman, 2018).

Categorical variables were summarized using frequencies and percentages. The association between household secondhand smoke exposure and recurrent ARI was examined using the Pearson chi-square test, with statistical significance set at $p < 0.05$. The high-exposure category contained no observations and was therefore omitted from the two-category association table.

RESEARCH RESULTS

Table 1. Participant characteristics and study variables (N = 93)

Variable	Results, n (%)
Age, years mean ± SD, (range)	3.25 ± 1.32(1-5)
1 year	25/26.9
2 years	14/15.1
3 years	20/21.5
4 years	20/21.5
5 years	14/15.1
Household secondhand smoke exposure	
Low (1–2 times/month)	56/60.2
Moderate (>3 times/week)	37/39.8
High (>7 times/week)	0/0.0
Recurrent ARI	
Yes	69/74.2
No	24/25.8

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As presented in Table 1, 50 participants (53.8%) were female, and the largest age group was 1 to under 2 years (25 children, 26.9%). The estimated mean age was 3.25 ± 1.32 years. Household secondhand smoke exposure was classified as low in 56 children (60.2%) and as moderate in 37 (39.8%), and no child fell into the high-exposure category. Recurrent ARI was reported in 69 children (74.2%). Table 2 demonstrates the distribution of recurrent ARI according to household secondhand smoke exposure.

Table 2. Household secondhand smoke exposure and recurrent ARI (N = 93)

Exposure level	Recurrent ARI	No recurrent ARI	Total	*p* value
Moderate (>3 times/week)	32/86.5	5/13.5	37/100.0	0.028
Low (1–2 times/month)	37/66.1	19/33.9	56/100.0	
Total	**69/74.2**	**24/25.8**	**93/100.0**	

As shown in Table 2, recurrent ARI was reported in 32 of the 37 children with moderate household secondhand smoke exposure (86.5%) and in 37 of the 56 children with low exposure (66.1%). The Pearson chi-square test showed a statistically significant association between household secondhand smoke exposure and recurrent ARI (p = 0.028).

DISCUSSION

The findings indicate a statistically significant association between household secondhand smoke exposure and recurrent ARI among children aged 1–5 years. Recurrent ARI was more frequent among children in the moderate-exposure category than among those in the low-exposure category. Because exposure and outcome were measured concurrently, this result supports an association but does not establish that secondhand smoke exposure preceded or caused recurrent ARI.

This result is consistent with broader evidence linking household secondhand smoke exposure with respiratory infection and respiratory morbidity in children (Vanker et al., 2017; Singh et al., 2022; Zhuge et al., 2020; Jayes et al., 2016). It also accords with recent Indonesian reports in which household cigarette smoke exposure or smoking within the family was associated with ARI among children (Sutrisminah, Umroh, Hartati, & Safitri, 2026; Masrel et al., 2024). Clinical studies further suggest that secondhand smoke exposure may be associated with a greater burden of respiratory illness. Home smoke exposure has been linked to poorer health-related quality of life among children with acute respiratory illness (Johnson, Wilson, Zhou, Johnson, Kenyon, Tieder, Dean, Mangione-Smith, & Williams, 2019), and objectively measured recent exposure was associated with greater severity of respiratory syncytial virus lower respiratory tract infection in infants (Maedel, Kainz, Frischer, Reinweber, & Zacharasiewicz, 2018).

A plausible mechanism for this association is impairment of airway defense. Tobacco smoke can increase oxidative stress and airway inflammation, disrupt epithelial integrity, alter immune responses, increase mucus production, and impair mucociliary clearance (Strzelak et al., 2018). These effects may reduce the ability of the respiratory tract to clear inhaled particles and microorganisms, thereby increasing susceptibility to infection. The present study did not directly measure tobacco-smoke constituents, indoor particulate concentrations, cotinine, mucociliary function, or immune biomarkers, and this mechanism therefore remains biologically plausible rather than demonstrated. The association between recent secondhand smoke exposure and greater RSV disease severity reported by Maedel et al. (2018) provides clinical support for the potential relevance of these mechanisms.

Gender and age were reported as participant characteristics only. Neither was tested for association with recurrent ARI, and they should therefore not be interpreted as explanatory factors in this sample.

The findings should be interpreted cautiously for several reasons. The cross-sectional design cannot establish temporal sequence or causality. Participants were selected purposively from a single health centre, which limits generalizability. Both exposure and recurrent ARI were assessed by

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questionnaire and may therefore be affected by recall and social-desirability bias. Biomarker studies show that caregiver report can underestimate children's tobacco smoke exposure (Park, 2020; Stallings et al., 2021; İnci et al., 2018). The exposure categories as defined also overlap, which creates a risk of misclassification unless the original scoring rule is clarified. Finally, the analysis was unadjusted and did not account for nutritional status, immunization history, breastfeeding, household crowding, ventilation, cooking fuel, parental education, socioeconomic status, or other potential confounders.

CONCLUSION

Household secondhand smoke exposure was significantly associated with recurrent ARI among children aged 1–5 years attending Balai Agung Community Health Centre. Recurrent ARI was more common among children classified as having moderate exposure than among those with low exposure. Because the study used a cross-sectional design and purposive sampling, these findings should be interpreted as an association rather than as evidence of causation.

SUGGESTION

Health-centre staff should reinforce smoke-free home education and encourage household members to avoid smoking indoors or in the vicinity of young children. Evidence from smoke-free policy research indicates that reducing children's tobacco smoke exposure can improve respiratory health outcomes (Faber, Been, Reiss, Mackenbach, & Sheikh, 2016; Radó, Mölenberg, Westenberg, Sheikh, Millett, Burdorf, van Lenthe, & Been, 2021; Turner, Mackay, Dick, Semple, & Pell, 2020). Reviews of household and primary-care interventions indicate that counseling, family involvement, follow-up, and improved support for healthcare professionals can help reduce children's secondhand smoke exposure (Zhou, Mak, & Ho, 2019; Kaur, Farley, Jolly, & Jones, 2019). Future studies should use mutually exclusive exposure categories, validated exposure and ARI measures, larger multicenter samples, and multivariable analyses that account for nutritional status, immunization, breastfeeding, housing conditions, cooking fuel, and socioeconomic factors. Objective exposure measures such as cotinine or indoor particulate monitoring could strengthen future evidence.

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