CIGARETTE SMOKE EXPOSURE AND ACUTE RESPIRATORY INFECTIONS AS RISK FACTORS OF STUNTING IN CHILDREN UNDER FIVE YEARS

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ABSTRACT

Introduction: Previous studies suggest that cigarette smoke exposure and acute respiratory infections (ARI) are considered contributing factors. We analyzed the risk of cigarette smoke exposure and ARI incidence in association with stunting in children under five years in an Indonesian rural setting where smoking and ARI prevalences are high. **Methods:** This is an observational analytical study with a case–control design. Secondary data on stunting were obtained from height measurements in March 2020, whereas data on cigarette smoke exposure and the incidence of ARI were the primary data obtained from interviews. **Results:** After adjusting for other variables in the multivariable analysis, high exposure of cigarette smoke exposure (OR = 9.85, 95% C1 = 2.23 – 43.48) and frequent ARI incidence (OR = 7.32. 95% CI = 1.42 – 37.68) still demonstrated a significant association with stunting in children under five years of age; history of low birth weight and family income were among the associated covariate variables. **Conclusion:** These findings are consistent with those of previous studies. Cigarette smoke exposure and acute respiratory infections are associated with stunting in children under five years of age. smoke-free home promotion and preventing ARI could prevent stunting in children under five.

Keywords: Stunting, malnutrition, cigarette smoke exposure, acute respiratory infection, children

INTRODUCTION

Stunting is a nutritional problem with severe long-term implications, such as cognitive and motor development impairments, metabolic problems, and disorders such as cardiovascular problems (Elba et al., 2024; Mulyani et al., 2025). Moreover, adults with a stunting history are at risk of giving birth to stunted offspring, resulting in iterative problems (Qoyimah et al., 2024). Indonesia has a high prevalence of stunting which might have severe implications for its future generations (The Ministry of Health of the Republic of Indonesia, 2023).

As a multifactorial problem, stunting is affected by environmental factors (Adi et al., 2023; Vilcins et al., 2018). Previous studies reveal cigarette smoke exposure as an environmental factor for stunting (Astuti et al., 2020; Muchlis et al., 2023; Muhammad Tahir Saenong et al., 2024). Considering its high prevalence in Indonesian family's setting (The Ministry of Health of the Republic of Indonesia, 2023), smoking could be a potential factor for stunting in children.

Cigarette smoke exposure increases the risk of acute respiratory infections (ARI) in children under five, whose immature immune systems make them more vulnerable. Recurrent ARI has been widely reported as a risk factor for stunting, as nutrients are diverted to infection recovery and appetite is reduced, leading to impaired growth (Black et al., 2013; Faridan et al., 2021; Putri et al., 2022).

The findings on cigarette smoke exposure and the incidence of ARI as risk factors of stunting in Indonesia however are limited. The previous studies perform results from cross-sectional approach. Also, they accounted for cigarette smoke exposure and ARI as factors of stunting separately. The current study is a case-control study simultaneously identifying cigarette smoke exposure and ARI as potential factors contributing to stunting in a rural area of Indonesia.

METHODS

This is an observational study employing case-control design. It compares stunted children (cases) to normal children (controls) to identify potential risk factors.

The research received a research ethics permit from the Research Ethics Commission of the Faculty of Dentistry, University of Jember (approval number: 938/UN25.8/KEPK/DL/2020) considering the collection procedure, confidentiality and voluntary.

A total of 112 samples were acquired randomly from 1,083 children aged 24–59 months from Jelbuk Sub-district, Jember District, East Java, Indonesia who underwent height measurements in March 2020 at Jelbuk Health Center. The number of cases was 44 and controls 68 which were not in accordance with number they should be (56 cases and 56 controls) because several cases were excluded. To meet the need for 112 samples, we added the control group as many as 12. The number of samples selected was based on sample calculation with power, P1: 0.33 and P2: 0.08 from previous study (Setiawan and Machmud, 2018) The selection of P1 and P2 was from the variable resulting the most samples.

To define dependent variable, we classified stunting into binary (case and control). Case was categorized as "Severely stunting" status according to the 2005 World Health Organization (WHO) standard (< -3 SD) while control categorized "Normal" status (≥ -2 SD) (The Ministry of Health of the Republic of Indonesia, 2023). The stunting categorization as "Severely stunting" status was intended to accentuate the distinction between stunting and normal growth. Sampling was performed using a simple random sampling technique. Children under five with a history of premature birth and congenital abnormalities, and those who gave birth not in a health facility or assisted by a health worker were excluded from the study.

The measurement of cigarette smoke exposure was based on the number of cigarettes smoked in houses or within 10 meters of the children, while the incidence of acute respiratory infections (ARI) was assessed according to the frequency of episodes in the past six months as diagnosed by health workers (doctor, nurse, or midwife). Using the median cut-off as the basis for classification, cigarette smoke exposure was divided into >28 cigarettes, 1-28 cigarettes, and no exposure, while ARI incidence was categorized into ≥3 episodes/6

months, 1–2 episodes/6 months, and none (Kusumawati et al., 2013; Solin et al., 2019).

Other covariates considered in this study were history of low birth weight and short birth length, diarrhea, and family income. Diarrhea was categorized by median frequency in the past six months (≥2, 1, or 0 episodes), while family income was classified as above the regional wage if exceeding 2,356,000 IDR.

We modelled a multiple logistic regression analysis with prior covariate selection. Covariate selection was conducted by performing chi-squared tests of potential covariate variables with stunting status. The covariate variables entered in the model were those with p-value < 0.25. All the analysis performed in the study used SPSS 16 version.

RESULTS AND DISCUSSION

Table 1 describes the characteristics of the respondents and the children. Most interviewed respondents were female (94%) aged 30 years (IQR: 10, min-max: 17-51). Majority of them were the mothers of the children (90.2%). Relatively equal proportion of sex of children were performed. The presence of family smoking was high among the children (79.5%).

Table 2 performs results of bivariate analysis of each independent and covariate variable with stunting in children under five years. Several covariates such as diarrhea, history of low birth weight, history of short birth length, and family income were selected in the final analysis.

The result of multivariate analysis is presented by Table 3. The analysis revealed that after adjusting for other covariates, cigarette smoke exposure and ARI were still associated with stunting in children under five years. It suggests that children exposed to more than 28 cigarettes/week were more likely to be stunted than the ones with no exposure (OR: 9.85, 95% CI: 2.23 – 43.48). Additionally, compared to children with no ARI in the last 6 months children with 3 times or more ARI tended to be stunted children (OR: 7.32, 95% CI: 1.42 – 37.68).

History of low birth weight and family income were among covariates associated with stunting. History low birth weight enhanced the likelihood

of stunting as many as 8.36 (95% CI: 1.87 – 37.31). Likewise, families with wage below regional four times more likely to have stunted children (95% CI: 1.07 – 15.01). Meanwhile, diarrhea and history of short births did not show any significant association with stunted children.

Table 1. Characteristics of the respondents and children

Characteristics	Median ± IQR (min-max)	n (%)
Age of the respondents	30 ± 10 (17-51)	
Sex of the respondents		
Male		6 (5,4%)
Female		106 (94,6%)
Respondent's relationship with the children		
Mother		101 (90,2%)
Grand mother		3 (2,7%)
Childminder		1 (0,9%)
Others		7 (6,3%)
Age of the children	41±16 (24-59)	
Sex of the children		
Male		55 (49,1%)
Female		57 (50,9%)
The presence of family smoking		
Absent		23 (20,5%)
Present		89 (79,5%)

Table 2. Bivariate analysis of independent and covariate variables with dependent variables

Variable	Case		Control		Total		p-value	OR (95% CI)
	n	%	*n*	%	*n*	%		
Independent variables								
Cigarette smoke exposure								
>28 Cigarettes/week	21	47.7%	12	17.6%	33	29.5%	0.001	6.42 (2.31–17.85)
1–28 cigarettes/week	14	31.8%	23	33.8%	37	33.0%		2.23 (0.83–6.02)
No exposure	9	20.5%	33	48.5%	42	37.5%		Ref.
ARI								
≥ 3 episodes/ 6 months	21	47.7%	6	8.8%	27	24.1%	<0.001	8.00 (2.25–28.48)
1-2 episodes/ 6 months	16	36.4%	46	67.6%	62	55.4%		0.80 (0.28–2.28)
None	7	15.9%	16	23.5%	23	20.5%		Ref.
Covariate variables								
Diarrhea								
≥ 2 episodes/ 6 months	13	29.5%	6	8.8%	19	17.0%	0.014	4.73 (1.59–14.08)
1 episode/ 6 months	9	20.5%	14	20.6%	23	20.5%		1.40 (0.53–3.73)
None	22	50.0%	48	70.6%	70	62.55		Ref

Variable	Case		Control		Total		p-value	OR (95% CI)
	n	%	*n*	%	*n*	%		
History of low birth weight								
Yes	17	38.6%	10	14.7%	27	24.1%	0.004	3.65 (1.48–9.03)
No	27	61.4%	58	85.3%	85	75.9%		Ref.
History of short birth length								
Yes	20	45.5%	12	17.6%	32	28.6%	0.001	3,89 (1.64–9.20)
No	24	54.5%	56	82.4%	80	71.4%		Ref.
Exclusive breastfeeding								
No	9	20,5%	18	26.5%	27	24.1%	0.467	0.71 (0.29–1.77)
Yes	35	79.5%	50	73.5%	85	75.9%		Ref.
Family income								
Below regional minimum wage	37	84.1	40	58.8%	77	68.8%	0.005	3.70 (1.44–9.48)
Above regional minimum wage	7	15.9%	28	41.2%	35	31.2%		Ref.

Table 3. Multivariate analysis of the independent variables with the dependent adjusting for the covariates

Variables	OR	95% CI	
		LCI	UCI
Independent variables			
Cigarette smoke exposure (ref = no exposure)			
>28 Cigarettes/week	**9.85**	***2.23**	**43.48**
1–28 cigarettes/week	2.44	0.63	9.40
ARI (ref = None)			
≥ 3 episodes/ 6 months	**7.32**	***1.42**	**37.68**
1-2 episodes/ 6 months	1.16	0.31	4.28
Covariate variables			
Diarrhea (ref = None)			
≥ 2 episodes/ 6 months	1.98	0.43	9.10
1 episode/ 6 months	3.39	0.90	12.76
History of low birth weight			
Yes	**8.36**	***1.87**	**37.31**
History of short birth length			
Yes	1.59	0.46	5.53
Family income (ref = above regional minimum wage)			
Below regional minimum wage	**4.00**	***1.07**	**15.01**

***Significantly associated**

Cigarette smoke exposure and ARI were associated with stunting. Children exposed to more than 28 sticks of cigarette smoke had nearly ten times higher odds of being stunted compared to those without exposure. Additionally, children who experienced ARI three times in the last six months had increased odds of stunting (OR: 7.32; 95% CI: 1.42–37.68).

Children with a history of low

birth weight had higher odds of being stunted compared to those with normal birth weight. Similarly, children from low-income families were more likely to experience stunting.

Consistent with prior evidence, children under five with smoking fathers exhibited significantly different z-scores of height-for-ages compared to those with non-smoking fathers, and prolonged exposure to cigarette smoker further increased the risk of stunting (Astuti et al., 2020; Muchlis et al., 2023; Wijaya-Erhardt, 2019).

Cigarette smoke exposure likely occurred not only during the current study but also before and throughout pregnancy. It could extend into the first 1,000 days of life, a critical period for child growth. Such exposure was associated with impaired fetal development, reduced birth weight and length, and elevated cotinine levels in umbilical cord blood, all of which significantly increase the risk of childhood stunting (Andriyani et al., 2019).

Cigarette smoke exposure also increases the likelihood of acute respiratory infections (ARI) in children under five, whose immature immune systems make them more vulnerable. Recurrent ARI has been consistently identified as a risk factor for stunting. Previous studies consistently demonstrated a strong association between ARI and stunting (Arifuddin et al., 2023; Purnama et al., 2025) with ARI amplifying the likelihood of impaired growth (Astuti, Handayani and Astuti, 2020). Spatial analyses further confirmed this finding (Kinyoki et al., 2017).

As one of the most common childhood infections, recurrent ARI contributes to malnutrition by reducing appetite and nutrient intake, particularly protein, which has a greater impact on young children than adults. Prolonged and repeated infections ultimately hinder linear growth and increase the risk of stunting (Black et al., 2013; Faridan et al., 2021; Islam et al., 2024; Putri et al., 2022).

In addition to reducing appetite, ARI diverts essential nutrients, particularly proteins needed for growth, toward antibody production, thereby limiting their availability for child development (Rodriguez et al., 2011). Recurrent ARI further depletes

nutritional resources, compounding growth impairment. The combined effects of diminished intake and nutrient diversion increase the risk of stunting, while children already experiencing stunting are more susceptible to ARI, creating a vicious cycle that exacerbates growth failure in those under five years of age (Rodriguez et al., 2011).

CONCLUSIONS

This study revealed that after adjusting for several covariates, both cigarette smoke exposure and ARI significantly increased the likelihood of stunted children. Several covariates, such as history of low birth weight and family income were also among associated factors. The findings indicate that preventing household cigarette smoke exposure is preventable action to prevent risks of stunting in children under five as well as risks of ARI which also lead to stunting. While addressing socioeconomic vulnerability remains essential, smoke-free home promotion and preventing ARI could improve the outcome.

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