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Associations Between Cooking Fuel Exposure and Acute Respiratory Infection Symptoms in Children Under 5 Years

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ABSTRACT

Background: Acute Respiratory Infection (ARI) has emerged as a significant public health issue due to its status as the primary cause of illness and death among children under the age of 5.
Methods: This study analyses the association between exposure of cooking fuel and risk factors for acute respiratory infection symptoms in children under 5 years of age. A cross-sectional approach using the 2017 Indonesia Demographic and Health Survey data. The data were analysed using logistic regression.
Results: Results of the study show that among 5473 households, 26% of children under 5 years old experience symptoms of ARI. In the final result of the multivariate analysis, cooking fuel was not significantly associated with ARI. ARI was significantly associated with poor wealth index (aOR = 0,9; CI 95% = 0,73−1,01) and unimproved drinking water sources (aOR = 1,3; CI 95% =1,03-1,52).
Conclusion: This study is expected to be a consideration for the government to immediately intervene for households with insufficient living habits and poor household sanitation. Also, increasing family awareness related to the risk of ARI in children under 5 years old.

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INTRODUCTION

Globally, Acute Respiratory Infection (ARI) has become a public health issue as it is the primary cause of morbidity and mortality in children under 5 years (1). WHO defines acute respiratory infections as caused by infectious agents. It has varied symptoms and usually appears quickly, ranging from a few hours to days after experiencing an infection. Symptoms include fever, cough, sore throat, and respiratory distress such as shortness of breath and wheezing (2). ARI is responsible for one out of every 50 fatalities among children aged 0-60 months and one out of every 28 deaths in infants aged 28 days to 6 months (3). ARI caused the deaths of 740,180 children under 5 years in 2019, contributing to 14% of all deaths of children under 5 years (4). Each year, more than 1,400 cases of pneumonia are reported for every 100,000 children. South Asia has the highest number of cases, with 2,500/100,000 children, followed by West and Central Africa, with 1,620/100,000 children (5). In developing countries, especially in Southeast Asia, ARI contributes to 33% of deaths among children under the age of 5 (6). Indonesia, alongside India, Nigeria, Pakistan, and China, accounted for over 54% of the 138 million pneumonia cases globally (7).

Various factors are linked to ARI in children under 5 years, including using solid fuel for cooking (8). WHO approximates that 2.4 billion households do not have access to clean cooking. These individuals utilise essential stoves and open fires, burning coal and biomass, including crop residues, wood, and animal dung (solid fuel).

Annually, more than 4 million premature deaths are caused by air contamination from cooking using solid fuels (9). Research indicates that particles inhaled from indoor air pollution contribute to over half of the premature deaths among children under 5 due to respiratory infections (10). In Indonesia, 90% of households do the indoor cooking. Most (72%) rely on liquefied petroleum gas (LPG) as their cooking fuel. Urban areas (86%) have a higher prevalence of LPG usage than rural areas (59%). Additionally, one-quarter of households (23%) utilise wood as their cooking fuel, with a higher prevalence in rural settings (38%) compared to urban ones (8%) (11).

Another study result found that living in rural areas ($p = 0.01$) is significantly associated with the incidence of ARI (12). The family with the poorest wealth index (OR = 1.91, 95% CI = 1.26-2.89) was significantly associated with ARI in children under 5 in Indonesia (13). The mother's education level is one of the most influential factors in the occurrence of ARI symptoms in children under 5, with a significance of 5% (14). Mothers who smoke and households with inadequate toilet facilities are likely to become risk factors for ARI in children (15). Furthermore, the prevalence of ARI occurs in children whose drinking water sources are unimproved (9.4%) (16). This study aims to determine the relationship between cooking fuel and the incidence of acute respiratory infections (ARI) in children under 5 years old in Indonesia.

METHOD

A cross-sectional study used data from the Indonesia Demographic Health Survey (IDHS) 2017. This study did not include households with children under 5 years of age with incomplete data. The study involved 5473 households with children under 5 from the Indonesia Demographic and Health Survey (IDHS). The independent variable was the type of cooking fuel used, categorised into two categories: non-solid fuels, which are LPG, electric fuel, natural gas, and biogas. Solid fuels include wood, coal, charcoal, kerosene, animal dung, grass and lignite [17]. The dependent variable was acute respiratory infection (ARI) symptoms in children under 5 years old. The criteria for children who had experienced coughing 2 weeks before the survey was conducted and if the cough was worsening because of shortness of breath or respiratory problems. Thus, the coded 1 for the ARI variable if both answers were "yes," which means the child had a cough and respiratory problems and coded as 0 if neither answer was met.

The statistical analysis involved univariate analysis, a chi-square test, and multivariate and logistic regression test. Control variables adjusted for in the analysis included type of residence (urban or rural), wealth index (rich, middle, or poor), toilet type (flush or pit latrine), drinking water source (good or bad), mother's education level (upper, middle, primary or no education), and mother's smoking status (yes or no). In the multivariate analysis, variables were selected based on the bivariate analysis results, those with a p-value ≤ 0,25, and then the variables were analysed in multivariate analysis. Variables with a p-value > 0.05 were sequentially removed from the model. If changes of OR were more than 10%, they were re-entered as potential confounding factors. The final model was derived when no variables remained with a p-value > 0.05, and no additional confounding variables were identified. [18].

RESULT

The results from 5473 samples showed that 1450 (26%) children under 5 years old experienced acute respiratory infection (ARI) symptoms. In the age group, children aged 0-2 years were 1375 (95%), and there were 75 (5%) children aged 3-5 years who experienced symptoms of Acute Respiratory Infection (ARI).

Table 1. Bivariate Model of Acute Respiratory Infection Symptoms in Children under 5 Years, 2017 IDHS (n=5473)

Variable	n	%	ARI		cOR	95% CI OR	*p*
			Non-ARI (n=4023) n(%)	ARI (n=1450) n(%)			
Cooking Fuel							
Non-Solid Fuel	3885	71	2898 (72,04)	987 (68,07)	1,0		
Solid Fuel	1588	29	1125 (27,96)	463 (31,93	1,2	1,06 -1,38	0,005

Residence type							
Urban	2864	52	2153 (53,53)	711 (49,03)	1,0		
Rural	2609	48	1870 (46,48)	739 (50,97)	1,2	1,06-1,35	0,003
Wealth Index							
Rich	2046	37	1576 (39,17)	470 (32,42)	1,0		
Middle	1096	20	809 (21,11)	287 (19,79)	0,7	0,62-0,80	0,000
Poor	2331	43	1638 (40,72)	693 (47,79)	0,8	0,71-0,99	0,032
Mother's Education							
Higher	989	18,07	731 (18,17)	258 (17,79)	1,0		
Secondary	3228	58,98	2409 (59,88)	819 (56,48)	0,7	0,34-1,35	0,268
Primary	1218	22,25	858 (21,33)	360 (24,83)	0,6	0,33-1,29	0,217
No Education	38	0,69	25 (0,62)	13 (0,90)	0,8	0,41-1,60	0,537
Mother's Smoking Status							
No	5396	99	3963 (98,51)	1433 (98,83)	1,0		
Yes	77	1	60 (1,49)	17 (1,17)	0,8	0,46-1,35	0,451
Type of Toilet							
Flush	5272	96	3893 (96,77)	1379 (95,10)	1,0		
Pit latrine	201	4	130 (3,23)	71 (4,90)	1,5	1,15-2,07	0,005
Drinking Water Source							
Improved Source	4941	90	3665 (91,10)	1276 (88)	1,0		
Unimproved Source	532	10	358 (8,90)	174 (12)	1,4	1,15-1,70	0,001

*cOR = crude Odds Ratio

Table 1 shows that most households have used non-solid cooking fuel with a total of 3885 (71%), but there are still used cooking fuel from solid fuel 1588 (29%). The risk of households using solid fuel to have children under 5 years old experiencing ARI symptoms was 1.2 times (OR = 1.2; 95% CI = 1.06-1.38) compared to households using non-solid cooking fuel.

The type of residence has a similar number, with 2864 (52%) children under 5 years old living in Urban areas and 2609 (48%) children under 5 years old living in Rural areas. The risk of living in a Rural area to have children under 5 years old experiencing ARI symptoms was 1.2 times (OR = 1.2; 95% CI = 1.06-1.35) compared to households in Urban areas.

Based on the wealth index, families with poor wealth index amounted to 2331 (42%), higher than other family wealth indexes. There were 1096 (20%) families in the middle wealth index and 2046 (37%) families in the rich

wealth index. The risk of families with poor wealth index having children under 5 years old experiencing ARI symptoms was 0.8 times higher (OR =0.8; 95% CI = 0.62-0.80), and families with middle wealth index was 0.7 times (OR = 0.7; 95% CI = 0.71-0.99) higher than rich wealth index.

Mothers with secondary education had a total of 3228 (59%) higher than mothers with other education levels, where mothers with no education level amounted to 38 (1%), mothers with primary education 1218 (22%) and mothers with higher education 989 (18%). The risk of mothers with no education to have children under 5 years old experiencing ARI symptoms was 0.8 times higher (OR =0.8; 95% CI = 0.41-1.60), mothers with primary education 0.6 times higher (OR = 0.6; 95% CI = 0.33-1.29) and mothers with secondary education 0.7 times higher (OR = 0.7; 95% CI = 0.34-1.35) than mothers with higher education.

In maternal smoking status, the majority of mothers did not have a smoking habit, as many as 5396 mothers (99%), but there were still 77 mothers who smoked. The risk of children under 5 years old experiencing ARI symptoms from smoking mothers was 0.8 times (OR = 0.9; 95% CI = 0.46-1.35) compared to non-smoking mothers.

Most households used flush toilets, 5272 (94%), but 201 (6%) households still used pit toilets. Children under 5 years old in households with pit toilets were 1.5 times more likely to experience ARI symptoms (OR = 1.5; 95% CI = 1.15-2.07) than flush toilets.

The number of households with improved drinking water sources was 4941 (90%) compared to 532 (10%) households with unimproved sources. The risk of children under 5 years old experiencing ARI symptoms in households with unimproved drinking water sources was 1.4 times (OR = 1.4; 95% CI = 1.15-1.70) compared to households with improved drinking water sources.

DISCUSSION

The multivariate analysis comprised wealth index and drinking water source (Table 2). The results of the multivariate analysis showed that families with a rich wealth index had a lower risk of children under 5 years old experiencing ARI symptoms. Families with a poor wealth index had 0.9 times the risk (OR = 0.9; 95% CI = 0.64-0.84) of children under 5 years old experiencing ARI symptoms compared to families with a rich wealth index. Furthermore, improved drinking water in the household has lowered the risk of children under 5 years old experiencing ARI symptoms. Households with unimproved drinking water sources had a risk of 1.3 times (OR = 1.3; 95% CI = 1.03-1.52) compared to households with improved drinking water sources.

Table 2. Results of Logistic Regression Model of Acute Respiratory Infection Symptoms in Children under 5 Years, 2017 IDHS (n=5473)

Variable	Category	*p*	aOR	95 C.I.for EXP(B)	
				Lower	Upper
Wealth Index	Rich		1,0		
	Middle	0,000	0,7	0,64	0,84
	Poor	0,072	0,9	0,73	1,01
Drinking Water Source	Improved		1,0		
	Unimproved	0,028	1,3	1,03	1,52

*aOR = adjusted Odds Ratio

The multivariate analysis found that ARI symptoms were significantly associated with wealth index and drinking water source, according to the research results on the determinants of symptoms of Acute Respiratory Infection (ARI) data from the 2017 IDHS. The research indicates that socio-demographic factors remain influential in determining Acute Respiratory Infections (ARI) among children under five in Indonesia. Factors such as the child's age, the mother's occupation, wealth status, and the type of residence showed significant correlations with ARI incidence in this demographic. It highlighted that the family wealth index and type of residence are essential aspects of improving child health in Indonesia (19).

Other researchers observed that households with a middle wealth index were associated with ARI symptoms in children under five. The findings revealed that children from families with a rich wealth index had a comparatively lower likelihood of ARI exposure than those from middle or lower-wealth index households. Rich wealth index households allocate more resources towards enhancing their children's healthcare and nutrition and adopting cleaner energy sources for cooking and heating, thereby mitigating the risk of ARI exposure (20).

This was followed by another study that linked the wealth index to the type of cooking fuel. The study stated that households with a poor wealth index prefer cooking fuel from wood (solid fuel) because wood is available in the neighbourhood, and people can collect it freely to be used as the first choice of cooking fuel (21). However, in this study, cooking fuel type and ARI were not associated in the multivariate analysis. This contradicts other studies that showed a strong association between ARI and solid fuel for cooking (22,23). Based on the discussion above, fuel selection is also related to the wealth index.

Furthermore, this study also found that children who drank water from unimproved sources had a higher risk of ARI symptoms than children who drank water from improved sources—linked with other studies which found that the drinking water source significantly influences ARI. The risk of children using unimproved drinking water sources is 71.5% times more likely to get ARI than children who use improved drinking water sources. This can be because water is at risk of contamination and is the leading cause of Acute Respiratory Infections (ARI) (24). According to research, it was analysing the lifestyle and household environment of children under 5 years with ARI symptoms using IDHS data in 2007, 2012 and 2017. The results stated that drinking water from unimproved sources was associated with a higher risk of ARI symptoms in children under 5 years (25).

CONCLUSIONS

In conclusion, the 2017 IDHS data shows that wealth index and drinking water sources have a significant relationship with the high incidence of ARI symptoms in children under 5 years old. This study is expected to be a consideration for the government to immediately intervene, especially in families with inadequate lifestyles and poor household sanitation. As well as increasing family awareness related to the risk of ARI in children under 5 years old.

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