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Multilevel Analysis of Lifestyle and Household Environment for Toddlers With Symptoms of Acute Respiratory Infection (ARI) in Indonesia in 2007, 2012, and 2017

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Abstract

Introduction. The morbidity and mortality rate of Acute Respiratory Tract Infection (ARI) in children under 5 is relatively high in Indonesia. Socio-demographic characteristic is considered one of the factors causing ARI in Indonesia. However, no study analyzed the prevalence of ARI among toddlers and the differences among the determinant factors in multiple periods. Thus, this study aimed to analyze the prevalence trends and determinant factors associated with ARI symptoms in children under 5 in Indonesia in 2007, 2012, and 2017. *Methods.* This study analyzed cross-sectional survey data from the Demographic and Health Survey (DHS) in Indonesia during 2007, 2012, and 2017. Bivariate and multivariate analysis with logistic regression was performed using Stata version 15. The final results were expressed in Adjusted Odds Ratio (AORs) and 95% Confidence Interval (CI). *Results.* The findings showed a progress in prevalence trends with a decrease in the percentage of children with ARI symptoms from 11.25% (2007), then 5.12% (2012) to 4.22% (2017). Risk factors for toddlers experiencing ARI symptoms were as follows: younger maternal age (OR: 1.13, 95% CI 0.70-1.81 in 2007, OR: 1.72, 95% CI 1.03-2.88 in 2012 and OR: 0.98, 95% CI 0.48-1.97 in 2017), smoking habits of family members (OR: 1.12, 95% CI 0.85-1.48 in 2012, OR: 1.23, 95% CI in 2017), poor drinking water quality (OR: 1.12, 95% CI 0.85-1.48 in 2012 and OR: 1.23, 95% CI in 2017), unavailable toilet facilities (OR: 1.27, 95% CI 1.04-1.56 in 2007, OR: 1.24, 95% CI 0.95-1.63 in 2012 and OR: 1.28, 95% CI 0.97-1.68 in 2017). *Conclusion.* There was a decrease in the prevalence of ARI symptoms among children in 2007, 2012, and 2017, with no prominent differences in other related factors. The lifestyle and household environmental factors such as the use of dirty fuel, the presence of smokers in the household, the poor quality of drinking water, unavailable toilet facilities in addition to the maternal age and child age were the determinant factors that must be prioritized and improved. Family self-awareness should also be enhanced for better prospects for toddler survival.

Keywords
ARI under 5 in Indonesia, lifestyle factors, household environmental factors, DHS 2007, 2012, 2017

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Introduction

Acute Respiratory Infection (ARI) is considered one of the global leading causes of death among children under 5, especially in developing countries. An uncontrolled increase in population density was associated with a less organized community in terms of social, cultural, and health aspects.[1] This condition could affect toddlers especially in families with low socioeconomic status or

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below the poverty line due to low intake of nutritious food and the inappropriate housing environment.[2]

The morbidity and mortality rate of ARI is relatively high, especially among toddlers.[3] ARI is one of the leading causes of death in children under 5 (16%). High incidence of mortality was recorded mainly in South Asia and Africa.[4] The percentage of ARI among children under 5 was 12.8% in Indonesia, with the highest distribution in 5 provinces: East Nusa Tenggara (18.6%), Banten (17.7%), East Java (17.2%), Bengkulu (16.4%), and Kalimantan Middle (15.1%).[5]

ARI could be linked to the lifestyles of toddlers and their household environments. A study showed the relationship between ARI among children under 5 and other factors such as smoking habits of family members, use of mosquito coils, occupancy density, and nutritional status.[32] Furthermore, a study conducted in Nigeria stated that ARI incidence was related to population density, residential density, air pollution, and environmental sanitation.[6] Moreover, a study conducted in Eastern Indonesia showed that ARI incidence was associated with the mother's low level of knowledge about child care, excusive breastfeeding, being exposed to cigarette smoke, and improper householding due to poverty.[7] Another study in the slums of Dibrugarh City mentioned that ARI incidence among toddlers was related to exclusive breastfeeding level, immunization, socio-economic characteristics, and air pollution level.[8]

A study in Indonesia showed the 25% of children under 5 experiencing ARI symptoms did not receive the required health service and medical treatment.[9] Another study also analyzed the determinants of ARI among children under 5 in Indonesia.[10] However, neither study assessed the progress related to ARI prevalence among toddlers nor compared the influence of ARI determinant factors in 2007, 2012, and 2017 in Indonesia. That is why this study aimed to analyze the difference in both prevalence and determinant factors of ARI among children under 5 in 2007, 2012, and 2017 in Indonesia.

Method and Material

Data Source

The study analyzed cross-sectional surveys (Indonesian Demographic and Health Survey, IDHS 2007, 2012, and 2017). A large-scale study estimated fertility, mortality, family planning, maternal and child healthcare services, and other relevant indicators across Indonesia at the national level. The IDHS data were obtained from several government agencies, such as the Indonesian Ministry of Health, the National Population and Family Planning Agency, and the Central Statistics Agency.

IDHS had a stratified 2-stage sampling design for both rural and urban areas. Some census blocks were selected by systematic probability proportional to the size of the household. Then, 25 households were chosen from each census block. After that, data were collected using interview forms, including household, male, female, and village forms.

Methodology

Both bivariate and multivariate analyses were used. Bivariate analysis showed the relationship between the study variables and children with ARI symptoms. Logistic regression was used in the multivariate analysis to show the influence of the characteristics of children, mothers, and households; besides relevant socio-economic and demographic variables on children with ARI symptoms. Data using Stata version 15 were presented in adjusted odds ratios (AORs) and 95% confidence intervals (CI).

Result Variable

In IDHS, children with ARI symptoms (dependent variable) were identified using the women's health questionnaire by asking eligible mothers (15-49 years) about the respiratory health of their children aged 0 to 59 months. Mothers were asked if their under-5 children had a cough during the last 2 weeks. If yes, mothers were asked whether their children were suffered from shortness of breath and rapid breathing due to fever. Children who met all of the abovementioned criteria were considered having ARI symptoms and coded with a value of 1 while children who did not meet the criteria were coded with a value of 0.

Variable Explanation

The study variables included the characteristics of children, mothers, and households, besides the theoretical relevant socio-economic and demographic characteristics. The characteristics of children were sex, age category (under 1, 1-2, and 3-4 years), the birth order (1-2, 3-4, and more than 4), children who were given vitamin A in the last 6 months and children who were given deworming medicine in the last 6 months.

The characteristics of mothers included the maternal age category (15-19, 20-24, 25-29, 30-34, 35-39, 40-44, and 45-49 years), the mother's education level (no school, not completed the first and second level of education, completed the first and second level of education and higher education), and the mother's employment status.

The characteristics of households included wealth quintiles (from poorest to richest), residence type (urban and rural), indoor smoking behavior of family members, area of residence (west, middle and east), cooking fuel (clean, unclean, and no food cooked), quality of drinking water source, handwashing habits and the availability of toilet facilities.

Ethical Approval

The study has ethical approval from the applied country Ethics Committee and ICF Macro. Research registration was carried out on the Demographic and Health Survey (DHS) website to obtain permission to use and analyze the data set.

Results

Table 1 shows the distribution and percentage of the dependent variable (children with ARI symptoms), and independent variables (the characteristics of children, mothers, and households; area of residence; wealth quintile; and type of residence) in 2007, 2012, and 2017 in Indonesia. The percentage of children with ARI declined from 11.25% in 2007, then 5.12% in 2012 to 4.22% in 2017. Thus, the results reflect the improvement of healthcare in Indonesia. Furthermore, supporting data indicated an increase in the percentage of both children receiving vitamin A in the last 6 months (63.08% in 2007, 57.42% in 2012, and 75.14% in 2017) and children receiving deworming medicine in the last 6 months (23.49% in 2012 and 36.56% in 2017). Supporting data also presented an increase in the percentage of mothers with a higher level of education (7.61% in 2007, 12.69% in 2012, and 15.21% in 2017). They also stated an increase in the percentage of using clean cooking fuel (19.18% in 2007, 57.03% in 2012, and 77.05% in 2017), family members who did not smoke at home (19.13% in 2007, 23.7 4% in 2012 and 76.26% in 2017), availability of toilet facilities (73.95% in 2007, 82.54% in 2012, 90.38% in 2017).

Table 2 presents that age had a significant effect on the susceptibility of ARI symptoms among children aged (1-2 years) as follows: 13.6% in 2007, 5.87 % in 2012, and 4.89 % in 2017. Furthermore, data showed that mothers with low education had higher susceptibility to having children with ARI symptoms. For mothers who did not complete their first level of education, the percentage of children with ARI symptoms was as follows: 14.19 % in 2007, 7.53% in 2012, and 5.67 % in 2017. The better the maternal education, the less the possibility of experiencing ARI symptoms among their children. The percentage of mothers with higher education who had children with ARI symptoms was as follows: 9.16 % in 2007, 3.33% in 2012, and 3.73% in 2017. Moreover, the results presented that the wealth quintile was a significant variable. The children had better facilities in the richer families reducing the risk of experiencing ARI symptoms. The percentage of children with ARI symptoms among the richest families was as follows: 8.68% in 2007, 3.59% in 2012, and 2.99% in 2017. Data also showed that the central part of Indonesia had the highest percentage of children with ARI symptoms as follows: 13.00 % in 2007, 6.63% in 2012, and 5.09% in 2017. Cooking fuel was also a significant factor as data showed that the percentage of children with ARI symptoms in families who cooked with dirty fuel was high: 11.62% in 2007, 6.2% in 2012, and 5.08% in 2017. The unavailability of toilet facilities was also associated with a higher percentage of children with ARI as follows:14.37 % in 2007, 7.13% in 2012, and 6.73% in 2017.

Table 3 showed the multivariate analysis for the dependent variable (children with ARI symptoms) with independent variable. Female children had a lower probability of experiencing ARI symptoms than male ones (OR: 0.89, 95% Cl 0.77-1.04 in 2007, OR: 0.79, 95% Cl 0.65-0.96 in 2012 and OR: 0.87 95% Cl 0.72-1.05 in 2017). Children in the 3rd and 4th born order had a higher risk of experiencing ARI symptoms (OR: 1.02, 95% Cl 0.84-1.25 in 2007, OR: 1.59, 95% Cl 1.25-2.02 in 2012 and OR: 1.12, 95% Cl 0.86-1.47 in 2017). Younger maternal age (15-19 years) was significantly associated with a higher risk of having children experiencing ARI symptoms (OR: 1.13, 95% Cl 0.70-1.81 in 2007, OR: 1.72, 95% Cl 1.03-2.88 in 2012 and OR: 0.98, 95% Cl 0.48-1.97 in 2017). On the other hand, the oldest maternal age group (45-49 years) was accompanied by a lower risk of having children with ARI symptoms (OR: 0.59, 95% Cl 0.27-1.30 in 2007, OR: 0.28, 95% Cl 0.12-0.65 in 2012 and OR: 0.35, 95% Cl 0.15-0.84 in 2017). Moreover, children of non-working mothers had lower risk of ARI symptoms (OR: 0.87, 95% Cl 0.74-1.02 in 2007, OR: 0.83, 95% Cl 0.67-1.02 in 2012 and OR: 0.80, 95% Cl 0.65-0.99 in 2017). Children in the richest families had low risk of experiencing ARI symptoms (OR: 0.77, 95% Cl 0.54-1.09 in 2007, OR: 0.83, 95% Cl 0.54-1.29 in 2012 and OR: 0.61, 95% Cl 0.42-0.89 in 2017). In Eastern Indonesia, children had low possibility of experiencing ARI symptoms (OR: 0.65, 95% Cl 0.49-0.86 in 2007, OR: 0.46, 95% Cl 0.29-0.73 in 2012 and OR: 0.48, 95% Cl 0.31-0.75 in 2017). Using of unclean cooking fuel was associated with a higher risk of experiencing ARI symptoms among children (OR: 1.15, 95% Cl 0.82-1.63 in 2007, OR: 0.89, 95% Cl 0.70-1.11 in 2012 and OR: 1.09, 95% Cl

Table 1. Socio-Demographic Characteristics of Participants in 2007, 2012, and 2017.

	2007		2012		2017	
Variables	N	%	N	%	N	%
Child characteristics						
Children with ARI symptoms						
Yes	2120	11.25	950	5.12	744	4.22
No	15436	88.75	15813	94.88	15879	95.78
Sex						
Male	9156	51.89	8669	50.93	8520	50.78
Female	8310	48.11	8094	49.07	8103	49.22
Age						
Under 1 years old	3642	21.17	3462	20.99	3205	19.12
1-2 years old	6833	39.21	6695	40.24	6698	40.44
3-4 years old	6991	39.62	6606	38.78	6720	40,44
Child birth order						
1st-2nd	10515	63.66	10913	69.69	10635	68.69
3rd-4th	4890	26.27	4299	22.99	4686	25.82
More than 4th	2061	10.07	1551	7.32	1302	5.5
Child who received Vitamin A in last 6 months						
Yes	10781	63.08	9058	57.42	12073	75.14
No	5949	32.97	5889	31.49	4225	23.07
Don't know	736	3.96	1816	11.09	325	1.8
Child who received the intestinal drug in last 6 months						
Yes	N/A	N/A	3899	23.49	5578	36.56
No	N/A	N/A	12727	75.77	10879	62.48
Don't know	N/A	N/A	137	0.74	166	0.96
Mother characteristics						
Age in years						
15-19	515	2.77	525	2.87	394	2.23
20-24	3454	20.53	3138	18.9	2549	16.18
25-29	5001	28.15	4729	27.83	4247	25.63
30-34	4282	23.95	4116	24.48	4427	26.42
35-39	2879	16.96	2843	17.2	3315	19.83
40-44	1090	6.11	1192	7.19	1395	7.99
45-49	245	1.53	220	1.51	296	1.72
Education level						
No education	739	3.43	510	2.05	240	1.08
Incomplete primary	2343	12.21	1662	8.43	1158	6.25
Complete primary	4513	28.87	3457	23.35	2968	19.49
Incomplete secondary	4262	25.04	4241	26.41	4283	28.29
Complete secondary	4263	42.63	4630	27.07	5021	29.68
Higher	761	7.61	2263	12.69	2953	15.21
Mother's occupation						
Not working	8874	51.44	7723	46.83	7865	49.29
Working	8592	48.56	9040	53.17	8758	50.71
Household characteristics						
Wealth quintile						
Poorest	5308	22.79	5008	21.6	4517	20.08
Poorer	3479	19.60	3362	19.41	3266	20.17
Middle	3044	19.62	3030	19.46	3087	20.46
Richer	2877	19.25	2826	20.4	2929	20.18
Richest	2758	18.74	2537	19.13	2824	19.11

(continued)

Table 1. (continued)

Variables	2007		2012		2017	
	N	%	N	%	N	%
Place of residence						
Rural	10818	58.31	9086	50.24	8425	51.34
Urban	6648	41.69	7677	49.76	8198	48.66
Region of residence						
West of Indonesia	9932	78.80	9710	80.02	9880	80.3
Middle of Indonesia	5571	18.64	5154	16.87	5090	16.5
East of Indonesia	1963	2.56	1899	3.11	1653	3.2
Cooking fuel						
Clean fuel	11.09	1918	7291	57.03	11248	77.05
Unclean fuel	88.80	15510	9436	42.73	5355	22.85
No Food cooked	0.11	38	36	0.24	20	0.11
Smoking pattern of house member inside the house						
Yes	N/A	N/A	13778	80.87	13029	76.26
No	N/A	N/A	2985	19.13	3594	23.74
Quality of drinking water source						
Good	11078	64.58	8669	57.73	9785	63.52
Bad	6388	35.42	8094	42.27	6838	36.48
Handwashing habit						
Observed	N/A	N/A	16235	97.76	15573	94.47
Not Observed	N/A	N/A	528	2.24	1050	5.53
Availability of toilet facilities						
Available	12290	73.95	13500	82.54	14858	90.38
Not available	5176	26.05	3263	17.46	1765	9.62
n Total	17466		16763		16623	

Source: Indonesia Demographic and Health Survey; IDHS 2007, 2012 and 2017.

0.85-1.40 in 2017). Children of smoker family members were more prone to experience ARI symptoms (OR: 1.12, 95% Cl 0.85-1.48 in 2012 and OR: 1.23, 95% Cl in 2017). Drinking water with bad quality was associated with higher vulnerability to ARI symptoms among children (OR: 1.02, 95% Cl 0.85-1.24 in 2007, OR: 1.21, 95% Cl 0.99-1.48 in 2012 and OR: 1.06, 95% Cl 0.85-1.32 in 2017). Unavailable toilet facilities were also related to a higher risk of children experiencing ARI symptoms (OR: 1.27, 95% Cl 1.04-1.56 in 2007, OR: 1.24, 95% Cl 0.95-1.63 in 2012 and OR: 1.28, 95% Cl 0.97-1.68 in 2017).

The study showed a remarkable decline in the prevalence of ARI symptoms in children under 5 between 2012 and 2017 in Indonesia. The prevalence of children with ARI symptoms was significantly reduced from 5.12% in 2012 to 4.22% in 2017 (Table 1). This success was a result of the substantial progress of the Sustainable Development Goals (SDGs). The SDGs were created by the United Nations (UN) and promoted as a global goal for sustainable development. The SDGs declaration, among others, aims to reduce child mortality and improves maternal health.[11]

The results in Table 1 approved the improvement in maternal and child healthcare from 2012 to 2017 in Indonesia, including the increase of the percentage of children receiving vitamin A in the last 6 months, children receiving deworming medicine in the previous 6 months, the rate of the education level of both college-level mothers and mothers who completed the secondary education level. Supporting data also showed the increase in the percentage of clean cooking fuel, family members who do not smoke at home, and drinking water of good quality.

Socio-demographic factors had a significant influence on the prevalence of ARI symptoms in toddlers in Indonesia. The results showed that ARI symptoms were most among children aged (1-2 years) in 2012 and 2017 (Table 2). This finding aligns with another research[12] in addition to basic health research showing that the highest ARI symptoms were among children aged 1 to 2 years (14.4%).[5] Children under 1 year had a

Table 2. The Relationship Between the Characteristics of Children and Mothers, Geographical Location, and Household Characteristics With the Status of Children With ARI Symptoms in 2007, 2012, and 2017 in Indonesia.

	2007					2012					2017				
	Children with ARI symptoms		Children without ARI Symptoms			Children with ARI symptoms		Children without ARI symptoms			Children with ARI symptoms		Children without ARI symptoms		
Characteristic	n	%¥	n	%¥	*P*-value	n	%¥	n	%¥	*P*-value	n	%¥	n	%¥	*P*-value
Child characteristic															
Sex of child															
Male	1168	11.79	7988	88.21	.151	545	5.69	8124	94.31	.0146*	397	4.46	8123	95.54	.1854
Female	952	10.67	7358	89.33		405	4.53	7689	95.47		347	3.96	7756	96.04	
Age of child															
Under 1 years old	385	9.2	3257	90.8	.000*	157	4.11	3305	95.89	.0191*	105	3.12	3100	96.88	.0036*
1-2 years old	972	13.6	5861	86.4		441	5.87	6254	94.13		349	4.89	6349	95.11	
3-4 years old	763	10.02	6228	89.98		352	4.89	6254	95.11		290	4.06	6430	95.94	
Child birth order															
1st-2nd	1265	11.4	9250	88.6	.475	588	4.66	10325	95.34	.0025*	473	4.17	10302	95.83	.7087
3rd-4th	608	11.38	4282	88.62		277	6.54	4022	93.46		205	4.21	4481	95.79	
More than 4th	247	9.94	1814	90.06		85	5.05	1466	94.95		66	4.85	1236	95.15	
Child who received Vitamin A in last 6 months															
Yes	1332	11.55	9449	88.45	.6497	552	5.67	8506	94.33	.0133*	566	4.23	11647	95.77	.0666
No	726	10.81	5223	89.19		299	4.39	5590	95.61		171	4.42	4054	95.58	
Don't know	62	10.19	674	89.81		99	4.34	1717	95.66		7	1.2	318	98.8	
Child who received an intestinal drug in last 6 months															
Yes	N/A	N/A	N/A	N/A	N/A	231	5.93	3688	94.07	.2906	275	4.45	5303	95.55	.4422
No	N/A	N/A	N/A	N/A		715	4.87	11992	95.13		467	4.11	10552	95.89	
Don't know	N/A	N/A	N/A	N/A		4	5.15	133	94.85		2	2.23	164	97.77	
Mother characteristic															
Age of mother in years															
15-19	75	12.20	440	87.80	.169	49	7.12	476	92.88	.1245	17	4.47	377	95.53	.2761
20-24	501	12.67	2953	87.33		178	4.92	2960	95.08		136	4.68	2413	95.32	
25-29	599	11.74	4402	88.26		285	5.85	4444	94.15		200	4.34	4047	95.66	
30-34	487	10.52	3795	89.48		225	4.58	3891	95.42		201	4.59	4226	95.41	
35-39	321	10.86	2558	89.14		141	4.81	2702	95.19		124	3.46	3191	96.54	
40-44	113	8.78	977	91.22		63	5.32	1129	94.68		58	3.95	1337	96.05	
45-49	24	7.25	221	92.75		9	1.74	211	98.26		8	2.02	288	97.98	

(continued)

Table 2. (continued)

Characteristic	2007					2012					2017				
	Children with ARI symptoms		Children without ARI Symptoms			Children with ARI symptoms		Children without ARI symptoms			Children with ARI symptoms		Children without ARI symptoms		
	n	%¥	n	%¥	*P*-value	n	%¥	n	%¥	*P*-value	n	%¥	n	%¥	*P*-value
Mother's level of education															
No education	97	15.5	642	84.50	.021*	28	5.62	482	94.38	.0006*	15	5.7	225	94.3	.0147*
Incomplete primary	372	14.19	1971	85.81		121	7.53	1541	92.47		62	5.67	1096	94.33	
Complete primary	582	11.47	3931	88.53		216	5.19	3241	94.81		162	5.11	2806	94.89	
Incomplete secondary	524	10.34	3738	89.66		274	5.86	3967	94.14		201	4.3	4082	95.7	
Complete secondary	430	10.46	3833	89.54		218	4.39	4412	95.61		183	3.44	4838	96.56	
Higher	115	9.16	1229	90.84		93	3.33	2170	96.67		121	3.73	2832	96.27	
Mother's occupation															
Not working	1023	10.53	7851	89.47	.059	404	4.73	7319	95.27	.141	318	3.88	7547	96.12	.106
Working	1097	12.01	7495	87.99		546	5.47	8494	94.53		426	4.54	8332	95.46	
Household characteristic															
Wealth quintile															
Poorest	787	13.86	4521	86.14	.001*	343	6.79	4665	93.21	.0002*	279	6.21	4238	93.79	.0000*
Poorer	470	12.66	3009	87.34		223	6.04	3139	93.96		156	4.94	3110	95.06	
Middle	338	10.56	2706	89.44		155	4.89	2875	95.11		113	3.39	2974	96.61	
Richer	297	9.92	2580	90.08		131	4.13	2695	95.87		107	3.51	2822	96.49	
Richest	228	8.68	2530	91.32		98	3.59	2439	96.41		89	2.99	2735	97.01	
Place of residence															
Rural	1414	11.93	9404	88.07	.088	566	5.88	8520	94.12	.0038*	428	4.6	7997	95.4	.0619
Urban	706	10.30	5942	89.70		384	4.36	7293	95.64		316	3.81	7882	96.19	
Region of residence															
West of Indonesia	1169	10.93	8763	89.07	.005*	532	4.88	9178	95.12	.0001*	402	4.1	9478	95.9	.0038*
Middle of Indonesia	794	13.00	4777	87.00		357	6.63	4797	93.37		283	5.09	4807	94.91	
East of Indonesia	157	8.46	1806	91.54		61	3.04	1838	96.96		59	2.57	1594	97.43	

(continued)

Table 2. (continued)

Characteristic	2007					2012					2017				
	Children with ARI symptoms		Children without ARI Symptoms			Children with ARI symptoms		Children without ARI symptoms			Children with ARI symptoms		Children without ARI symptoms		
	n	%¥	n	%¥	*P*-value	n	%¥	n	%¥	*P*-value	n	%¥	n	%¥	*P*-value
Cooking fuel															
Clean fuel	162	8.38	1756	91.62	.008*	356	4.28	6935	95.72	.0018*	469	3.97	10919	96.03	.0171*
Unclean fuel	1958	11.62	13572	88.38		592	6.2	8844	93.8		274	5.08	5081	94.92	
No food cooked	0	0	18	100		2	12.67	34	87.33		1	1.1	19	98.9	
Smoking pattern of House member inside the house															
Yes	N/A	N/A	N/A	N/A	N/A	810	5.33	12968	94.67	.0864	625	4.52	12544	95.48	.081
No	N/A	N/A	N/A	N/A		140	4.24	2845	95.76		119	3.26	3475	96.74	
Quality of drinking water source															
Good	1268	10.57	9810	89.43	.037*	463	4.5	8206	95.5	.0032*	406	4.01	9379	95.99	.2030
Bad	852	13.31	5536	86.69		487	5.96	7607	94.04		338	4.57	6500	95.43	
Handwashing habit															
Observed	N/A	N/A	N/A	N/A	N/A	923	5.12	15312	94.88	.9560	697	4.17	15016	95.83	.3157
Not observed	N/A	N/A	N/A	N/A		27	5.19	501	94.81		47	5.05	1003	94.95	
Availability of toilet facilities															
Available	1367	10.15	10923	89.85	.000*	704	4.7	12796	95.3	.0001*	628	3.95	14370	96.05	.0000*
Not available	753	14.37	4423	85.63		246	7.13	3017	92.87		116	6.73	1649	93.27	

Source: Indonesia Demographic and Health Survey; IDHS 2007, 2012, and 2017.
¥Proportions are weighted.
**P*-value $<$.05.

low risk of infection as the parents usually keep them away from pollution. Moreover, babies are less vulnerable to ARI symptoms due to mothers' compliance with exclusive breastfeeding along with complementary foods. Breastfeeding enhanced immunoglobulins of babies protecting them from ARI.[13] However, other studies opposed these results showing that children under 1 year had a higher risk of ARI symptoms.[14]

The study showed that girls were less exposed to ARI symptoms compared to boys (Table 3). The data in 2012 and 2017 aligned with the results of previous research.[15] Similarly, basic health research in Indonesia showed that the percentage of girls under 5 experiencing ARI symptoms (12.4%) was less compared to boys (13.2%).[5] Boys like to move more outside and inside their homes exposing themselves to air pollution and increasing the risk of having lung infections.

The study revealed that younger maternal age (15-19 years) was significantly associated with a higher risk of having children experiencing ARI symptoms; similar results were approved in previous studies.[14,16] Compared to older mothers, younger mothers may have less experience in caring for their children. Similarly, this study presented that children of the most senior maternal age group (45-49 years) had a lower risk of ARI symptoms in 2012 and 2017 (Table 3).

The results, mainly in 2017, showed that children of rich families were less vulnerable to ARI symptoms (Table 3). This is confirmed by other studies mentioning that the frequency and severity of ARI symptoms elevated along with poverty.[17] In addition, data showed that poverty was associated with improper toilet facilities, crowding, and chronic malnutrition.[17] In addition, poverty was linked to using both improper water sources[18] and unclean fuel.[19] Thus, the abovementioned factors could be considered as risk factors for experiencing ARI symptoms in children. This aligns with this study showing that dirty cooking fuel, inadequate drinking water quality, unavailable toilet facilities were associated with a higher risk of ARI symptoms in children (Table 3).

The study showed that children in families who use dirty cooking fuel had a high risk of developing ARI symptoms, although this relationship was not statistically significant (Table 3). However, the percentage of children with ARI symptoms was significantly higher in families using unclean cooking fuel in 2012 and 2017 as follows: 6.2% in 2012 and 5.08% in 2017 (Table 2). According to some literature, children who were exposed to smoke and lived in households that use dirty cooking fuel were more vulnerable to developing ARI symptoms compare to others who were not exposed to smoke and live in households using clean fuels.[15,20] These results are consistent with previous research in Nigeria showing that dirty cooking fuel was a significant risk factor for experiencing ARI symptoms in children.[6,21]

In Indonesia, most households (72%) use clean fuel (liquefied petroleum gas or LPG). LPG is used more in urban areas (86%) than in rural areas (59%). While fewer households (23%) use dirty fuel (wood): 38% in rural areas, and 8% in urban areas.[31] This goes along with a study in Bangladesh showing that the risk of ARI symptoms in children is higher in households using solid fuels by 18%.[22] Similarly, in Afghanistan, children in families who cook with solid fuels were 1.19 times at risk of experiencing ARI than children from families that use cleaner fuels.[23] In Zimbabwe, the likelihood of developing ARI symptoms was more than double among children in households using solid fuels (ie, wood, dung, or straw) than others using cleaner fuels.[24] In Ethiopia, the children in households using high-polluting fuels were at a higher risk of experiencing ARI symptoms 3 times than others in families using low-polluting fuels.[25] Exposure to dirty fuels increases the risk of viral and bacterial infections caused by bronchial reactivity.

The study showed that toddlers of family members who smoke indoors had a higher risk of experiencing ARI symptoms, although this relationship was not statistically significant (Table 3); however, a study in Padang in Indonesia stated that this relation was significant among children under 5 .[26] Furthermore, the smoking patterns of family members were related to the incidence of ARI symptoms among toddlers in Surabaya, Indonesia.[27] Similarly, Tazinya et al[28] showed that families who smoke were at greater risk of experiencing ARI than non-smokers in a hospital in Cameroon. Choube et al[29] also stated that the incidence of ARI increased among toddlers whose family members smoke inside the home. Children as passive smokers are at high risk since their immune system is still weak.

Data in Eastern Indonesia, prominently, showed a low percentage of children with ARI symptoms in 2 years (Table 3). Geographically, Eastern Indonesia has a high distribution of islands and consists of Sulawesi, Maluku, Irian/Papua, West Nusa Tenggara, and East Nusa Tenggara. According to the Indonesian Statistical Agency, the population of Eastern Indonesia was less than other regions which may play a role in the low number of children with ARI symptoms. IDHS data collection took place from 24th July to 30th September 2017 (IDHS, 2017). However, according to the Indonesian Meteorology, Climatology, and Geophysics Agency, the dry season reached its peak in July to September 2017. This could be linked to the high number of ARI cases in Indonesia in 2017 since pathogenic microbes survive longer in the air in dry weather. In

Table 3. Prediction of Children With ARI Symptoms in 2007, 2012, and 2017 in Indonesia.

	2007			2012			2017		
		95% CI			95% CI			95% CI	
Variable	OR	Lower	Upper	OR	Lower	Upper	OR	Lower	Upper
Child characteristic									
Sex									
Male	1.00			1.00			1.00		
Female	0.89	0.77	1.04	0.79*	0.65	0.96	0.87	0.72	1.05
Age									
Under 1 year old	0.66***	0.54	0.82	0.78	0.58	1.05	0.61***	0.45	0.82
1-2 years old	1.00			1.00			1.00		
3-4 years old	0.071***	0.59	0.85	0.83	0.67	1.02	0.82	0.66	1.01
Child birth order									
1st-2nd	1.00			1.00			1.00		
3rd-4th	1.02	0.84	1.25	1.59***	1.25	2.02	1.12	0.86	1.47
More than 4th	0.84	0.61	1.16	1.28	0.85	1.94	1.29	0.86	1.94
Child who received Vitamin A in last 6 months									
Yes	1.00			1.00			1.00		
No	0.94	0.76	1.16	0.76**	0.61	0.94	1.15	0.89	1.48
Don't know	0.86	0.55	1.35	0.76	0.57	1.03	0.29	0.78	1.13
Child who received the intestinal drug in last 6 months									
Yes	N/A	N/A	N/A	1.19	0.92	1.53	1.08	0.87	1.33
No	N/A	N/A	N/A	1.00			1.00		
Don't know	N/A	N/A	N/A	1.19	0.27	5.26	0.96	0.18	5.19
Mother characteristic									
Age in years									
15-19	1.13	0.70	1.81	1.72*	1.03	2.88	0.98	0.48	1.97
20-24	1.21	0.94	1.55	1.17	0.83	1.63	1.04	0.78	1.39
25-29	1.13	0.91	1.41	1.39*	1.08	1.80	0.97	0.74	1.27
30-34	1.00			1.00			1.00		
35-39	1.04	0.81	1.34	0.92	0.67	1.27	0.69*	0.51	0.95
40-44	0.82	0.56	1.19	0.98	0.61	1.57	0.76	0.51	1.14
45-49	0.59	0.27	1.30	0.28**	0.12	0.65	0.35*	0.15	0.84
Education Level									
No education	1.61	0.96	2.62	1.00	0.52	1.94	1.11	0.56	2.20
Incomplete primary	1.36*	1.04	1.79	1.17	0.81	1.68	1.12	0.73	1.71
Complete primary	1.09	0.86	1.37	0.83	0.64	1.09	1.10	0.82	1.48
Incomplete secondary	1.00			1.00			1.00		
Complete secondary	1.13	0.90	1.42	0.86	0.64	1.14	0.92	0.71	1.19
Higher	1.09	0.72	1.64	0.70	0.47	1.05	1.08	0.77	1.51
Mother's occupation									
Not working	0.87	0.74	1.02	0.83	0.67	1.02	0.80*	0.65	0.99
Working	1.00			1.00			1.00		
Household characteristic									
Wealth quintile									
Poorest	1.01	0.79	1.29	0.95	0.71	1.28	1.26	0.94	1.68
Poorer	1.00			1.00			1.00		
Middle	0.86	0.64	1.17	0.89	0.64	1.23	0.69*	0.49	0.95
Richer	0.85	0.65	1.11	0.82	0.58	1.17	0.71	0.51	1.01
Richest	0.77	0.54	1.09	0.83	0.54	1.29	0.61**	0.42	0.89
Place of residence									
Rural	1.00			1.00			1.00		
Urban	1.08	0.86	1.35	0.94	0.74	1.21	1.11	0.89	1.38

(continued)

Table 3. (continued)

	2007			2012			2017		
		95% CI			95% CI			95% CI	
Variable	OR	Lower	Upper	OR	Lower	Upper	OR	Lower	Upper
Region of residence									
West of Indonesia	1.00			1.00			1.00		
Middle of Indonesia	1.09	0.94	1.29	1.16	0.95	1.41	1.07	0.87	1.32
East of Indonesia	0.65	0.49	0.86	0.46***	0.29	0.73	0.48***	0.31	0.75
Cooking fuel									
Clean fuel	1.00			0.89	0.70	1.11	1.09	0.85	1.40
Unclean fuel	1.15	0.82	1.63	1.00			1.00		
No food cooked	1.00	N/A	N/A	2.40	0.43	13.58	0.28	0.03	2.33
Smoking pattern of House member inside house									
Yes	N/A	N/A	N/A	1.12	0.85	1.48	1.23	0.95	1.59
No	N/A	N/A	N/A	1.00			1.00		
Drinking water source quality									
Good	1.00			1.00			1.00		
Bad	1.02	0.85	1.24	1.21	0.99	1.48	1.06	0.85	1.32
Handwashing habit									
Observed	N/A	N/A	N/A	1.00			1.00		
Not observed	N/A	N/A	N/A	0.83	0.48	1.44	0.89	0.59	1.32
Toilet facility									
Available	1.00			1.00			1.00		
Not available	1.27*	1.04	1.56	1.24	0.95	1.63	1.28	0.97	1.68

Source: Indonesia Demographic and Health Survey,2007, 2012 and 2017.
Proportions are weighted.
*P-value $<$ .05. **P-value $<$ .01. ***P-value $<$ .001.

turn, pathogenic microbes can cause respiratory problems in children.[30]

The main limitation of this study was the use of secondary data. Moreover, possible bias, related to the prevalence of ARI symptoms, could happen during data collection of mothers' self-reported information. The data were cross-sectional, therefore a causal relationship between factors was not assessed. Moreover, the study did not assess the children who received intestinal drugs last 6 months, smoke patterns of family members, and handwashing habits from IDHS 2007.

The strength of this study was the ability to show the trend and progress in prevalence and factors associated with ARI symptoms among children under 5 in 2007, 2012, and 2017 in Indonesia. Demographic Health Survey (DHS) data has been validated, thus the results can be generalized. The DHS survey variables were defined in the same way in different countries to compare the results across countries.

Conclusion

This study approved the success of Indonesia in decreasing the prevalence of ARI symptoms among toddlers in 2007, 2012, and 2017 respectively with little differences in other related factors. Lifestyle and household environmental factors such as the use of dirty fuel, the presence of smokers in the household, the poor quality of drinking water, low availability of toilet facilities in addition to the maternal age and child age were all determinant factors that should be prioritized and improved. Health workers must immediately implement interventions especially for families with inadequate lifestyles and poor household environments. Moreover, family self-awareness should be enhanced for better prospects for toddler survival.

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