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The use of household biomass and the incidence of acute respiratory infection (ARI) in toddlers in Lampung Regency 2020

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Abstract

Purpose: Acute Respiratory Infection (ARI) is a significant cause of illness and mortality in children under five, with those under two years being the most vulnerable. The World Health Organization (WHO) estimated in 2017 that ARI contributed to up to 3 million deaths worldwide, particularly in low-income countries. In Indonesia, the 2018 Basic Health Research reported an ARI prevalence of 12.80%, while Lampung Province recorded a rate of 11.3%. In Central Lampung District, the prevalence of ARI with acute nasopharyngitis was 19.70%. One of the primary risk factors for ARI in toddlers is indoor air pollution, often linked to household cooking fuel. Biomass fuel combustion generates smoke and pollutants that can lead to respiratory infections. This study analyzed the association between household biomass fuel use and the incidence of ARI in toddlers in the Seputih Surabaya Health Center working area, Central Lampung, in 2020. **Methods:** This was an observational analytic study using a cross-sectional design. One hundred four participants from the Seputih Surabaya Health Center area were included. Univariable analysis was performed using frequency distribution tables, bivariable analysis utilized the Chi-Square test, and multivariable analysis applied logistic regression. **Results:** The findings indicated a significant relationship between household biomass fuel use and toddler's ARI incidence (p = 0.000). Multivariate logistic regression analysis showed that biomass fuel use contributed 25% to the risk of ARI in toddlers. **Conclusion:** Several factors, including biomass fuel use, maternal age, maternal education, toddler age, exclusive breastfeeding, exposure to cigarette smoke, and socio-economic status, were found to be associated with ARI incidence in toddlers.

Keywords: ARI; air pollution; biomass; toddlers; respiratory infection

INTRODUCTION

The World Health Organization (WHO) states that a nation's health indicators can be seen from the morbidity and mortality rates, including infants and toddlers [1]. The toddler period is a period of growth and development and a critical period in toddlers aged 1 to 5 years; the immune system is not yet perfect, causing toddlers to be susceptible to infection [2]. One of the infectious diseases in toddlers is respiratory tract infection, acute respiratory infection (ARI) [3]. Especially more vulnerable groups to suffer from ARI, toddlers aged < 2 years (4). ISPA, or what is known as acute respiratory infection (ARI), is a respiratory infectious disease that is one of the causes of illness and death in children [5]. This can occur in developing and developed countries with low or middle per capita income and is still a global health issue [6]. WHO estimates that deaths of toddlers due to ISPA amounted to 3 million deaths, and around 153,000 deaths were dominated by children aged <2 years [7]. Indonesia ranks sixth place in infant mortality due to pneumonia, which is 19,000 deaths per year. The prevalence of ISPA in toddlers in Lampung province is 11.3% [8].

The effects of ARI on toddlers have been linked to exposure to pollution from the use of cooking fuels indoors room [9]. The fuel is biomass such as wood, charcoal, twigs, straw, and grass [10]. Exposure to smoke from biomass burning can contribute to suffering from ARI in toddlers [11]. Smoke from biomass produces CO, CO_2, and other substances that can harm health if inhaled in large quantities [12]. The presence of children in the room with the level of air pollution caused by smoke burning can increase the risk of ARI in children [13]. Pollution due to smoke contributes to around 14% of people suffering from ARI [14].

According to the 2017 Indonesian Demographic Health Survey (SDKI), 90% of cooking activities are indoors. The type of LPG fuel in urban areas is 86% greater than in rural areas. In rural areas, about 59%, the use of firewood in urban areas is 8%, and in rural areas 38% [15]. The use of firewood is higher in the region, and rural areas are closely related to the socio-economic conditions of families as a determinant of the quality and quantity of life [16]. Some households use more than one type of fuel, including LPG and biomass; this is based on usage requirements [17]. Biomass fuels that are used without knowing the side effects of the combustion results and bringing children along when cooking have a higher risk of suffering from ARI [18].

METHODS

This research is an analytical observational study with a cross-sectional research design. This research design is used to see the relationship between household biomass variables and acute respiratory tract infection (ARI) variables in toddlers and see the relationship between ISPA variables and independent variables (maternal age, maternal education, exclusive breastfeeding, immunization, exposure to cigarette smoke, maternal occupation, socio-economic) which are observed individually. Simultaneously at the same time or period. This research was conducted in the working area of Seputih Surabaya Health Center, Central Lampung Regency. The study was conducted from April to June 2020.

The study's sample consisted of toddlers who lived in the working area of the Seputih Surabaya Health Center, Central Lampung Regency. A hypothesis test was used to calculate the sample size. Different proportions were used, and a research sample of 86 respondents was obtained, which increased by 20% to anticipate dropouts, resulting in 104 toddler respondents.

Sampling using simple random technique sampling is a method of taking samples from a population that is carried out randomly without paying attention to the strata in the population. Data analysis was used in this study, including univariable, bivariable, and multivariable analysis. Univariable analysis was used to identify characteristics of biomass variables, ISPA, immunization, exclusive breastfeeding, nutritional status, maternal age, maternal occupation, exposure to cigarette smoke, and social economy in the form of a frequency table to see the characteristics proportionally from each research subject.

Bivariate analysis to see the relationship between variables dependent and independent using the Chi-Square test (χ^2) with a significance level of $\alpha < 0.05$ at the confidence level (CI) of 95%. Multivariable analysis determines the relationship between dependent and independent variables by considering confounding variables using the logistic regression test.

RESULTS

Table 1 shows that the mother's age is dominated by the 21-34 age group (62.50%), and the mother's education is at the junior high school/Islamic junior high school level. Equally (43.27%), the mother's occupation is a housewife (35.58%), female gender in toddlers (59.62%) and male gender (40.38%), with the highest age is 25-36 months.

Table 1. Distribution of characteristics of respondents (n=104)

Variable	n	%
Mother's age (years)		
<20	13	12.50
21-34	65	62.50
≥ 35	26	25.00
Mothers's education		
High education	17	16.35
Low education	87	83.65
Mother's job		
Housewife	37	35.58
Work	67	64,42
Toddler gender		
Male	42	40.38
Female	62	58.62
Toddler age (months)		
<12	15	14.42
13-24	23	22.12
25-36	27	25.96
37-48	24	23.08
49-60	15	14.42
Toddlers weight according to age		
More	7	6.73
Normal	57	54.81
Thin	40	38.46
Toddler body length according to age		
Tall	7	6.73
Normal	50	48.08
Stunting	47	45.19
Toddler weight according to age		
More nutrition	3	2.88
Good nutrition	61	58.65
Malnutrition	40	38.46
Exclusive breastfeeding		
Yes	16	15.38
No	88	84.62
Immunization		
Complete	71	68.27
Incomplete	33	31.73
Biomass		
No	12	11.54
Yes	92	88.46
Cooking place		
Outdoor/open	3	2.88
Separate building	14	13.46
In the house	87	83.65
Cigarette smoke exposure		
No	13	12.50
Yes	91	88.46
ISPA		
No	12	11.54
Yes	92	88.46
Socio-economic		
High	6	5.77
Currently	9	8.65
Low	89	85.58

The toddlers with non-exclusive breastfeeding status are (84.62%), and immunization in toddlers is (68.27%) in the complete category. The use of cooking fuel is the biomass type with the highest biomass (88.46%), and the cooking place is inside the house (83.65%). The cigarette smoke exposure status obtained a percentage of (87.50%) in the category exposed, the category of ISPA in toddlers was (88.46%), and the low socio-economic category was (85.58%).

Table 2 shows the proportion of biomass-use households that use more biomass types (88.46%) than non-biomass (11.54%). The results of the *chi-square* analysis *square* on biomass usage obtained *a value* of 0.0000 < 0.05 with an OR value of 24.36; this means household biomass use has a 24.36 times greater chance risk of suffering from ISPA in toddlers compared to the use of non-biomass fuels.

The age of mothers in the 21-34 year group (62.50%) who have toddlers with ARI category compared to the mother group <20 years (12.50%). The chi-square analysis obtained a p-value of 0.0060 in the maternal age group 21-34 years. The p-value = 0.0053 in the maternal age group >35 years this is It can be seen that the *p*-value in the older age group is smaller than the value of ÿ=0.05 (p<0.05). It can be concluded that maternal age has a significant relationship with the incidence of ISPA in toddlers in the working area of Seputih Health Center, Surabaya Central Lampung Regency.

Maternal education was in the low category (83.65%), and the *chi-square* analysis results obtained a p-value of 0.0009 <0.05 with an OR value of 7.3. which means that low maternal education has a 7.3 chance of increasing the incidence of ISPA in toddlers compared to mothers who have higher education, or low maternal education has a significant relationship with incidents of ARI in toddlers.

The exclusive breastfeeding variable has a significant relationship with the incidence of ARI in toddlers, with a p-value of 0.0076. In contrast, the maternal occupation and immunization variables do not have a significant relationship with the incidence of ARI. The *chi-square* test analysis on the toddler age variable has a significant relationship with the incidence of ISPA in toddlers p=0.0318. In contrast, the variables gender and nutritional status of toddlers did not show a significant relationship. In addition, the socio-economic variables and exposure to cigarette smoke have a significant relationship. with the incidence of ISPA p<0.05.

Table 2. Relationship between biomass use, mother's age, and mother's education with the incidence of Acute Respiratory Tract Infections (ARI) in toddlers

Independent variables	ISPA						OR	CI 95%	p-value
	Yes		No		Total				
	n	%	n	%	n	%			
Biomass									
No	5	5.43	7	58.33	12	11.54	1	1	1
Yes	87	94.57	5	41.67	92	88.46	24.36	4.32-137.11	0.0000
Mother's age									
<20 years	8	8.70	5	41.67	13	12.50	1	1	1
21-34 years	59	64.13	6	50.00	65	62.50	6.145	1.39-27.032	0.0060
≥35 years	25	27.17	1	8.33	26	25.00	15.62	1.15-210.59	0.0053
Mother's education									
High	11	11.96	6	50.00	17	16.35	1	1	1
Low	81	88.04	6	50.00	87	83.65	7.363	1.85-29.20	0.0009
Mother's job									
Housewife	32	34.78	5	41.67	37	35.58	1	1	1
Work	60	65.22	7	58.33	67	64.42	1.33	0.39-4.59	0.6410
Exclusive breastfeeding									
Yes	11	11.96	5	41.67	16	15.38	1	1	1
No	81	58.33	7	58.33	88	84.62	5.25	1.34-20.56	0.0076
Immunization									
Yes	64	69.57	7	58.33	71	68.27	1	1	1
No	28	30.43	5	41.67	33	31.73	0.61	0.17-2.11	0.4339
Toddler gender									
Male	37	40.22	5	41.67	42	40.38	1	1	1
Female	55	59.78	7	58.33	62	59.62	1.06	0.31-3.62	0.9237
Toddler age									
<2 years	37	40.22	1	8.33	38	36.54	1	1	1
>2 years	55	59.78	11	91.67	66	63.64	0.13	0.01-1.15	0.0318
Toddlers' weight according to age									
Overweight	6	6.25	1	8.33	7	6.73	1	1	1
Normal	50	54.35	7	58.33	57	54.81	1.19	0.12-11.61	0.8806
Underweight	36	39.13	4	33.33	40	38.46	1.50	0.13-16.27	0.7371
Toddlers' height according to age									
Height	6	6.25	1	8.33	7	6.73	1	1	1
Normal	47	51.09	3	25.00	50	48.08	2.61	0.22-30.34	0.5729
Stunting	39	42.39	8	66.67	47	45.19	0.81	0.08-7.87	0.8575
Toddlers weight according to height									
Overnutrition	2	2.17	1	8.33	3	2.88	1	1	1
Normal	52	56.52	9	75.00	61	58.65	2.88	0.22-36.52	0.396
Undernutrition	38	41.30	2	16.67	40	38.46	9.5	0.50-180.35	0.0663
Socio-economic									
High	4	4.32	2	16.67	6	5.77	1	1	1
Middle	6	6.52	3	25.00	9	8.65	1.00	0.10-9.66	1.000
Low	82	89.13	7	58.33	89	85.58	5.58	0.86-39.86	0.0403
Cigarette exposure									
Exposed	8	8.70	5	41.67	13	12.50	1	1	1
Not Exposed	84	91.30	7	58.33	91	87.50	7.50	1.77-31.62	0.0012
Cooking place									
Outdoor/open	2	2.17	1	8.33	3	2.88	1	1	1
Separate building	10	10.87	4	33.33	14	13.46	1.25	0.07-19.55	0.0417
In the house	80	86.96	7	58.33	87	83.65	5.71	0.43-74.56	

Table 3. Relationship between biomass use, maternal age, maternal education, toddler age, exclusive breastfeeding

External Variables	Biomass						OR	CI 95%	p-value
	Yes		No		Total				
	n	%	n	%	n	%			
Mother's age									
<20 years	9	9.78	3	25.00	12	11.54	1	1	1
21-34 years	57	61.96	8	66.67	65	62.50	2.37	0.51-1091	0.2514
≥35 years	26	28.26	1	8.33	27	25.96	8.66	0.67-111.63	0.0458
Mother's education									
High	12	13.04	5	41.67	17	16.35	1	1	1
Low	80	86.96	7	58.33	87	83.65	4.76	1.23-18.30	0.0121
Toddlers age									
<2 years	35	38.04	3	25.00	38	36.54	1	1	1
>2 years	57	61.69	9	75.00	66	63.46	0.54	0.13-0.34	0.3789
Exclusive breastfeeding									
Yes	9	9.87	7	58.33	16	15.38	1	1	1
No	83	90.22	5	41.67	88	84.62	0.07	0.01-0.34	0.0000
Cigarette exposure									
Not Exposed	11	11.96	2	16.67	13	12.50	1	1	1
Exposed	81	88.04	10	83.33	91	87.50	1.47	0.21-7.69	0.6442
Socio-economic									
High	4	4.35	2	16.67	6	5.77	1	1	1
Middle	5	5.43	4	33.33	9	8.65	0.62	0.06-5.84	0.6776
Low	83	90.22	6	50.00	89	85.58	6.91	0.98-48.73	0.0239

Table 4. Logistic regression analysis model of the relationship between biomass use, maternal education, toddler age, exclusive breastfeeding, cigarette smoke exposure, socioeconomics with the incidence of Acute Respiratory (ARI) in toddlers

Variable	Model 1 OR (CI 95%)	Model 2 OR (CI 95%)	Model 3 OR (CI 95%)	Model 4 OR (CI 95%)	Model 5 OR (CI 95%)	Model 6 OR (CI 95%)	Model 7 OR (CI 95%)
Biomass							
No	1	1	1	1	1	1	1
Yes	3.193*** (1.73-4.65)	3.257*** (1.61-4.90)	3.000*** (1.37-4.62)	3.126*** (1.31-4.94)	2.820** (0.70-4.93)	3.181** (0.79-5.57)	2.376 (0.79-5.57)
Mother's age							
<20 years		1	1	1	1	1	1
21-34 years		2.907* (0.32-3.87)	1.798* (0.07-3.52)	2.077* (0.16-3.99)	2.094* (0.12-4.06)	1.677 (-0.45-3.81)	2.267 (-0.45-3.81)
≥35 years		2.505 (-0.04-5.05)	2.398 (-0.31-5.10)	3.118* (0.09-6.14)	3.129* (0.22-6.03)	2.572 (-0.32-5.47)	3.026* (-0.32-5.47)
Mother's education							
High			1	1	1	1	1
Low			1.467 (-0.09-3.03)	1.629 (-0.12-3.38)	1.684 (-0.09-3.46)	1.200 (-0.79-3.19)	1.590 (-0.79-3.19)
Toddlers age							
<12 months				1	1	1	1
>12 months				-2.703* (-5.20-0.20)	-2.564* (-5.04-0.08)	-2.556* (-5.07-0.03)	-3.949* (7.27-0.62)
Exclusive breastfeeding							
Yes					1	1	1
No					0.656 (-1.76-3.07)	0.759 (-1.84-3.36)	1.243 (-1.54-4.03)
Cigarette exposure							
Not Exposed						1	1
Exposed						1.810 (-0.39-4.01)	1.135 (-1.08-3.71)
Socio-economic							
High						1	1
Low							-1.832 (-5.68-2.02)
Middle							0.946 (-2.77-4.66)
Cons	-0.336 (-1.148-0.81)	-2.069* (-4.02-0.11)	-2.623** (-4.55-0.69)	-0.958 (-3.58-1.67)	-1.444 (-4.64-1.75)	-2.482 (-5.96-0.99)	-1.657 (-6.32-3.00)
N	104	104	104	104	104	104	104
Pseudo R"q	0.259	0.344	0.389	0.477	0.481	0.516	0.570
AIC	59.15	56.82	55.47	50.88	52.61	52.03	52.01

Table 3 shows the relationship between independent and external variables; it can be seen that the variables of maternal age, maternal education, breast milk exclusive, and socio-economic have a significant relationship with biomass use p<0.05. In contrast, the toddler age and cigarette smoke exposure variables do not have a significant relationship with biomass use p>0.05.

Table 4 shows a model to determine the relationship between external variables and ISPA in toddlers for each independent variable. The analysis results in the above modeling are determined based on the p-value (<0.05) in the bivariate analysis. The addition of variables external factors can also affect the OR value and the level of significance in the ISPA variable for toddlers. Determining the best model is by having a value with The largest pseudo R~q, the smallest AIC value and the best model is model 7.

DISCUSSION

Respondent characteristics

Most toddlers in this study were >2 years old, and more were female with the status of not breastfeeding. Exclusive but has complete immunization and good nutrition status. The mother's age is dominated by the productive age, namely 21-34 years with a low level of education and low socio-economic status with the status of a working mother. The use of biomass is classified as high and has a status of exposure to cigarette smoke.

The relationship between biomass use and the incidence of ISPA in toddler

Bivariate analysis results on biomass use showed significant results with the incidence of ISPA in toddlers. This is effective if ISPA is associated with the use of biomass; biomass-burning smoke can increase indoor air pollution and cause ARI in toddlers [12,19,20]. The use of biomass is 2.09 times more risky, causing the incidence of ISPA in toddlers compared to using clean fuels [13]. The pollution caused indicates that biomass burning can be detrimental to health due to breathing in the air, which is continuously exposed to pollution [21,22].

Relationship between independent variables with the incidence of ARI in toddlers

The results of the univariable analysis showed that maternal age dominated in the 21-34 age group or the productive category and had toddlers with ISPA of 64.13%. The bivariate analysis showed that the *chi-square* test obtained a p-value = 0.0041, which means a significant relationship exists between maternal age and the incidence of ARI in toddlers. There is a significant relationship between maternal age and the incidence of ARI in toddlers [9,13,16,23].

Maternal education obtained a p-value of 0.009, which means there is a significant relationship with the incidence of ARI in toddlers. A mother's low educational level is twice as likely greater risk of contracting ARI compared to mothers who are highly educated(11). Toddlers who have mothers with low education have a 2.80 higher chance of suffering from ISPA in toddlers than toddlers who have mothers with higher education [24].

Mother's occupation has no relationship with the incidence of ISPA in toddlers p>0.05. A mother's employment status is related to the opportunity to stimulate the child; a mother who does not work can stimulate their children compared to working mothers [25]. The mother's work does not affect the incidence of ARI in toddlers; this can be linked to the mother's parenting pattern [26]. The mother's employment status does not necessarily influence toddlers to suffer from ISPA. Mothers with employment status can still provide services to children in the growth process flower [23]. The toddler's gender does not have a significant relationship with the incidence of ISPA in toddlers p>0.05. Generally, there are no differences in the incidence of ARI caused by bacteria or viruses according to gender [27]. Another study stated that there was no relationship between gender and the incidence of ARI in toddlers p = 0.843 [28]. It is explained that the female gender has no relation to the incidence of ARI in toddlers p=0.994 [29].

Toddler age in the bivariate analysis is related to the incidence of ISPA in toddlers (30). Toddlers are very vulnerable to ARI; this is indicated by the results of the p-value = 0.001, which states that the age of toddlers is related to the incidence of ARI; this age is very susceptible to infection, which attacks the body due to the body's defense system being less than optimal. The age is >2 years, which is when toddlers start to have contact with people outside who are more likely to have an increased incidence of ARI in toddlers [31].

Nutritional status in this study was reviewed from 3 anthropometrics, which stated that there was no significant relationship between nutritional status and the incidence of ISPA in toddlers. Nutritional status in toddlers has no relationship with the incidence of ISPA [29]. ISPA in toddlers occurs due to a lack of parental care patterns. This can affect the nutritional status of toddlers, and this can happen due to a lack of knowledge and skills of mothers in stimulating children's nutrition [32]. Nutritional status in toddlers does not immediately cause ARI in toddlers [33].

Exclusive breastfeeding in bivariate tests has a

significant relationship with the incidence of ISPA in toddlers. Toddlers who do not receive exclusive breastfeeding have a weakened immune system. Become reduced and easy to be attacked by diseases such as ISPA [33]. Exclusive breastfeeding status has a significant relationship with the incidence of ISPA in toddlers p=0.001; breast milk can stimulate growth and development and the immune system in toddlers [34].

Immunization in toddlers showed results that did not have a significant relationship, p>0.05. Most of the ISPA develops from a disease that can be prevented by immunization, so the chances of children with complete immunization status are smaller compared to children who do not have complete immunization status [35].

The cooking place in the bivariate analysis has a significant relationship p<0.05. The cooking place is a location for cooking activities in food processing [23]. Exposure to cigarette smoke obtained a p-value <0.05, which means there is a significant relationship between exposure to cigarette smoke and incidents of ISPA in toddlers. Exposure to cigarette smoke increases the chance by 2 times greater risk of causing ARI in toddlers [3]. Toddlers who have smokers in the house will be more susceptible to experiencing ISPA because the toddler inhales cigarette smoke carried out by family members; the presence of smokers in the house does not move toddlers when they want to smoke [17,33].

Socio-economic obtained a p-value <0.05, which means the social economy has a meaningful relationship with events ISPA in toddlers. Toddlers who live in low socio-economic households are more likely to suffer from ISPA compared to toddlers in high socio-economic households. This is associated with the use of fuel by mothers and the cooking process inside the house, which can cause air pollution inhaled by the respiratory tract [23].

CONCLUSION

This study shows that the use of biomass, maternal age, maternal education, toddler age, exclusive breastfeeding, smoking exposure to cigarettes, and socioeconomic conditions can increase the incidence of ARI in toddlers. In contrast, the mother's occupation, toddler gender, nutritional status, and immunization did not significantly correlate with the incidence of ARI in toddlers in the Seputih Surabaya Health Center working area, Central Lampung, in 2020.

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