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ORIGINAL ARTICLE

Risk Factors of the Upper Airway Disease among Under-Five Children in Mountainous Area, Indonesia

MIFBAKHUDDIN MIFBAKHUDDIN, SUHARDI SUHARDI, RATIH SARI WARDANI, Sayono Sayono

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ABSTRACT

Objective: To assess the occurrence and the associated factors of airway disease among under-five children in a mountainous region of Indonesia.

Study Design: Cross-sectional study

Place and Duration of Study: The study was conducted in the mountainous region of Temanggung district, Central Java Province, Indonesia from October to December 2018.

Material and Methods: As many as 49 under-five children were selected randomly from villages. Questionnaire-based interviews on individual characteristics, behavioral factors, airway disease occurrence, and observations of the physical environment of houses were carried out in data collection. Data were analyzed descriptively and analytically by using the SPSS 16.0 version.

Results: As many as 51% of under-five children were female and 71.4% were toddlers. The physical condition of houses showed dusty floors (36.7%), non-waterproof walls (53.1%), and poor kitchen ventilation (40.8%). The behavioral factors indicated the use of wood fuel (53.1%) and often holding their child while cooking (44.9%). Upper airway disease occurred among 69.4% of under-five children, and it was significantly associated with the condition of house walls ($p=0.032$), house floors ($p=0.001$), kitchen ventilation ($p=0.022$), and the use of wood fuel ($p=0.008$) and held the child while cooking ($p=0.001$), respectively.

Conclusion: This study finds that 69.4% of under 5 children had upper airway disease occurrences among under 5 children. It was associated with the not waterproofing of house walls, dusty floors, poor kitchen ventilation, the use of wood fuel, and holding a child when cooking. A sanitation program for residential improvement is needed.

Key Words: Upper airway disease, Under-five children, Mountainous area, Indoor aerosol

INTRODUCTION

Airway disease is a frequent infectious disease among under 5 children which is currently a global public health problem.^{1,2} Clinical manifestations of

upper airway diseases are cough, sore throat, runny nose, nasal congestion, headache, low-grade fever, facial pressure, sneezing, malaise, and myalgia. Several risk factors for the diseases are close contact, asthma, allergic rhinitis,

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smoking, immunocompromised diseases, and anatomical anomalies.³ The global prevalence of upper airway disease is estimated to be 13%¹ with a mortality rate of 9.8%. Geographically, the disease occurrence varied among African,⁴ Asian,⁵ and American⁶ countries. National data on the incidence of upper airway disease in Indonesia is estimated at 20.6%, but a number of studies in Java,⁷ Sumatera,⁸ and Papua⁹ showed a variation in the occurrence of the disease.

Mostly, studies on airway disease reveal the incidence of this disease based in urban and rural areas, as well as sanitation aspects. Several risk factors of upper airway disease were identified including under-nutrition,^{10,11} low birth weight, wood, and biomass fuels, holding children while cooking,^{4,12} poor ventilation, and passive smoking¹², household poverty,^{12,13} wood, and mosquito coil smoke, airway history in the family,^{10,14} household density and public transport use,¹⁴ cow dung use, and mother literacy.¹¹ In Indonesia, the airway disease risk factors were parental education and knowledge, family income, occupancy density, the presence of smokers in the family,⁷ floor type and use of mosquito coils, room lighting and ventilation,⁷ infant birth weight, and exclusive breastfeeding.⁸

There are no specific studies on the occurrence of upper airway disease among under 5 children and risk factors in mountainous areas in Indonesia, and similar studies in other countries are also limited. Studies in Nepal and Columbia reported that airway disease was found in the mountains,¹⁵ with lower morbidity rather than in the low elevations.^{6,16} Factors associated with the airway disease occurrence in these regions were the use of firewood,¹⁶ family history of airway disease, race, economic status, malnutrition, and high humidity.⁶ Mountainous areas are found in Indonesia, including parts of the Temanggung district. Data for 2020 showed 20,291 cases of airway disease in the district, but there is no specific analysis of the risk factors for airway disease in this mountainous area. This study aims to assess the association between physical and behavioral factors and airway disease occurrence among under-five children in the mountainous

region of Temanggung district, Central Java, Indonesia.

MATERIAL AND METHODS

The cross-sectional study was conducted in Kentengsari village, Candiroto sub-district, Temanggung district, Central Java Province, Indonesia where the airway disease occurrence was highest among 14 villages in the sub-district. The altitude average of the village is 1,061 m above sea level and at the geographical coordinates of 7.2300 °S and 110.0301 °E with air temperature ranges of 18 – 29 °C. The sample size was determined by Cochran's formula¹⁷ to estimate the proportion (occurrence) of disease; $n = \frac{Z^2 pq}{e}$; where Z is the statistic for a 95% of level confidence = 1.96; p is an expected prevalence = 0.9685; $q = 1 - p = 0.0315$; and e is the level of precision = 0.05. The population density of the village was 775 people/km², including the low category. There were 153 under 5 children in this village who accessed the Integrated Health Services (IHS) in the period of October to December 2018. As many as 49 under-five children were randomly selected and the parents were interviewed.

Data was collected using questionnaires and field observation. The questionnaire consists of individual characteristics, behavioral factors (smoker in the family, opening house ventilation, using wood fuel), and the existence of child/children with upper airway disease in the last three months. Field observation covers physical factors (house ventilation, kitchen ventilation, lighting intensity, temperature, and humidity)¹⁸ based on the requirements of house sanitation. House and kitchen ventilation were categorized into poor (<10% of floor area) and proper (≥10% of floor area) and the existence of a chimney above the kitchen. Air temperature and humidity were measured 24 hours by a hygrometer (HAAR-SYNT HYGRO) and recorded the lowest and highest values. The air temperature was categorized as unhealthy (<22 or >30 °C) and healthy (22-30 °C), while the humidity was categorized as unhealthy (<40 or >60%) and healthy (40-60%). Indoor (room) lighting was measured by lux meter (DX-100 Digital Lux meter, Takemura Electric Works Ltd), and the results were categorized into unhealthy (<60 lux) and

healthy (≥ 60 lux) groups. Opening house ventilation was measured by the frequency of opening doors, windows, and other ventilation a week for air change' and the results were categorized into rarely (0-3 days/week) and often (4-7 days/week). A smoker (s) in the family is categorized as the father or other family member(s). Interviews were conducted with parents followed by an inspection of the physical factors of the houses.

Statistical analysis was done using SPSS 16.0 version. The descriptive and analytic analysis results were presented in figures and tables. The strength of the risk factors association was determined by the value of the prevalence ratio (PR) and reinforced by the 95% confidence interval. The protocol of this study was reviewed and obtained ethical approval from the Ethics Committee of Health Research of Public Health Faculty, Universitas Muhammadiyah Semarang number 220/KEPK-FKM/Unimus/2018.

RESULTS

In total, male participants were more than females, and the majority were under 36 months. In the last three months, as many as 69.4% of under-five children had airway disease onsets with an average of 1.44 times, equivalent to 5.76 episodes/child/year (tables 1 and 3). The smoking

behavior was found in all families with an intensity of 8-9 cigarettes per day. The majority of smokers are fathers (table 3).

The majority of houses have poor ventilation and unhealthy humidity, although most of them have healthy lighting and air temperature range. The physical condition of the houses showed that more than 50% have non-waterproof walls, 36.6% have dusty soil and cement plaster floors, about 40% have unhealthy kitchen ventilation, and only about 55% of houses with good lighting. Almost 96% of the houses have a good temperature, but only 4.1% of houses have healthy humidity ranges (tables 1 and 2). In the context of healthy behavior, almost one-third of the families rarely open the house ventilation, more than 53% use wood fuel, and almost 45% of households often carry children when cooking (table 3). Table 4 showed the risk factors that were significantly associated with the incidence of upper airway disease, namely the type of house wall ($p = 0.032$, $PR = 5.042$ and 95% $CI = 1.316-19.317$), floor conditions ($p=0.001$, $PR = 1,938$ and 95% $CI = 1,378-2,724$), kitchen ventilation ($p = 0.022$, $PR = 7,312$ and 95% $CI = 1,427-37,469$), use of wood fuel ($p=0.008$, $PR = 9,266$ and 95% $CI = 1,805-47,769$), and the habit of holding children while cooking ($p = 0.001$, $PR = 22,615$ and 95% $CI = 2,652-192,878$).

TABLE 1. Descriptive statistics of individual characteristics, upper airway disease occurrence, and physical factors of the house in a mountainous area (n=49)

Variables	Minimum	Maximum	Mean	Std deviation
Under-five children age (month)	1.0	56.0	28.20	15.65
Ventilation area (% of floor area)	2.4	20.8	9.15	4.91
Daily smoked-cigarettes	2.0	16.0	8.63	4.05
Frequency of airway disease	0.0	2.0	1.00	0.79
Indoor Air temperature ($^{\circ}C$)	21.0	23.0	22.29	0.54
Indoor Air humidity (%)	60.0	85.0	73.94	4.01
Light intensity in the room (lux)	30.0	130.0	72.55	24.51

TABLE 2. Physical factors of houses in settlements in a mountainous area (n=49)

Variables	Number	Percentage
Type of house wall		
Non-water proof	26	53.1
Water proof	23	46.9
Condition of house floor		
Dusty	18	36.7
Clean	31	63.3
Kitchen ventilation		
poor	20	40.8

Proper	29	59.2
Light intensity (lux)		
< 60	22	44.9
≥ 60	27	55.1
Air temperature ($^{\circ}C$)		
<20 or >30	2	4.1
22 – 30	47	95.9
Humidity (%)		
<40 or >70	47	95.9
40 – 70	2	4.1

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TABLE 3. Characteristics of person and health behavior among family members in a mountainous area (n=49)

Variables	Number	Percentage
Sex		
Male	25	51.0
Female	24	49.0
Age group (years)		
1 – 3	35	71.4
4 – 5	14	28.6
Occurrence of airway disease		
Yes	34	69.4
No	15	30.6
Opening ventilation of the house		
Rare	16	32.7
Always (daily)	33	67.3

The use of wood fuel		
Yes	26	53.1
No	23	46.9
Holding the child when cooking		
Often	22	44.9
Rare	27	55.1
The smoker(s) in family		
Father	40	81.6
Other family members	9	18.4
Number of smoked cigarettes a day		
7 or more	34	69.4
0 – 6	15	30.6

TABLE 4. Bivariate analysis of risk factors of upper airway diseases occurrence among under 5 children in a mountainous area (n=49)

Risk factors	Occurrence of airway disease				p	PR	95% CI
	Yes		No				
	N	%	N	%			
Sex of under-five children							
Male	16	64.0	9	36.0	0.599	0.593	0.173 – 2.034
Female	18	75.0	6	25.0			
Age group (years)							
1 – 3	25	71.4	10	28.6	0.735	1.389	0.372 – 5.181
4 – 5	9	64.3	5	35.7			
Type of house wall							
Not waterproof	22	84.6	4	15.4	0.032*	5.042	1.316 – 19.317
Waterproof	12	52.2	11	47.8			
Condition of house floor (type)							
Dusty (soil and cement)	18	100	0	0.0	0.001*	1.938	1.378 – 2.724
Clean (tile)	16	51.6	15	48.4			
Kitchen ventilation							
Poor	18	90.0	2	10.0	0.022*	7.312	1.427 – 37.47
Proper	16	55.2	13	44.8			
Light intensity (lux)							
< 60	18	81.8	4	18.2	0.164	3.094	0.820 – 11.672
≥ 60	16	59.3	11	40.7			
Air temperature (in Celsius degree)							
<20 or >30	2	100	0	0.0	1.000	1.469	1.208 – 1.786
22 – 30	32	68.1	15	31.9			
Humidity (%)							
<40 or >70	33	70.2	14	29.8	0.523	2.357	0.138 – 40.402
40 – 70	1	50.0	1	50.0			
Opening house ventilation(s)							
Rarely	14	87.5	2	12.5	0.097	4.550	0.884 – 23.407
Always (daily)	20	60.6	13	39.4			
The use of wood fuel							
Yes	20	90.9	2	9.1	0.008*	9.266	1.805 – 47.769
No	14	51.9	13	48.1			
Hold child when cooking							
Often	21	95.5	1	4.5	0.001*	22.615	2.652 – 192.88
Rarely	13	48.1	14	51.9			

The smoker(s) in family							
Father	29	72.5	11	27.5	0.427	2.109	0.477 – 9.328
Other family members	5	55.6	4	44.4			
Number of smoked cigarettes a day							
7 or more	26	72.2	10	27.8	0.500	1.625	0.428 – 6.171
0 – 6	8	61.5	5	38.5			

PR = prevalence ratio

* = significantly associated (p<0.05)

DISCUSSION

This study reports for the first time an analysis of risk factors for the incidence of upper airway disease in mountainous areas in Indonesia. A literature search found only four studies that explicitly analyzed the occurrence and risk factors for airway disease at high altitudes.^{6,18-20} This study provides further information on the airway disease problem in a high altitudinal region so that appropriate control measures can be made. In general, airway disease in the study site showed a prevalence rate of 69.4%. It was different from the other studies that found 3.27 and 8-9 episodes of ARI/child/year.^{19,20} This prevalence was also lower than the District Health Office report, similar to the study reports in Nepal and the Republic of Columbia where the prevalence of airway disease decreases with increasing the altitude of the area, although the range of airway disease prevalence in both countries is lower.^{6,18} The result was also lower than the occurrence of airway disease in mountainous areas of Vietnam.²¹ Even though Temanggung is a mountainous area, the highest altitude is only 1,061 m asl so the condition of environmental physical factors is still within the range of health requirements, and is also exposed to sunlight 12 hours per day. This condition can inhibit the growth of pathogens, including the cause of airway disease.

The occurrence of upper airway disease in children has been reported worldwide.¹ Studies on upper airway disease analyze the disease occurrence based on geographic conditions and focus on aspects of the home environment, population behavior, and health history of under-five children. This study found five associated factors that were significant to the occurrence of upper airway disease in a mountainous area, namely the condition of walls and floors, kitchen ventilation, the use of wood fuel, and holding children while cooking. The wood-fuel-use factor is in line with the finding in Columbia,⁶ whereas

the other factors such as smoking behavior, room lighting and ventilation, under-nutrition, low birth weight, history of airway disease, and low education and health literacy are found at low elevation areas.^{7,11-13}

This finding indicated that less than 50% of houses were made of permanent walls and waterproof. The walls of most houses were made of bamboo or wood, so they become damp during the rainy season because of the high humidity. This condition supports the growth of bacteria and viruses in indoor air so that it provides a higher opportunity for infection, including airway disease. More than 36% of houses use soil and cement plaster floors which they were dusty and hard to be cleaned. Moist walls and dusty floors allowed pathogens to survive longer and give a greater risk of infection. airway disease is caused by several types of viruses and bacteria²¹ where the humidity influences their growth. Poor quality of kitchen ventilation limits air circulation and triggers indoor air pollution.²³ Kitchen smoke is trapped in the kitchen room and increased the burden of chemical exposure. This condition stimulates irritation of the respiratory tract mucosa and facilitates infection.²⁴ The solid fuel use and organic material combustion will produce smoke which causes indoor air pollution,²⁵ inspirable particulate materials, and several chemical compounds such as carbon monoxide, nitrogen oxides, formaldehyde, benzene, 1,3 - butadiene, polycyclic aromatic hydrocarbons (PAHs), and other harmful gases.²⁴ Wood smoke aerosol causes a high level of PM_{2.5} and CO gas exposure and stimulates health effects such as ARI and lung function.²⁶ The habit of holding children while cooking allows simultaneous exposure to these pathogens and harmful materials and chemical compounds. Although mountainous areas have a relatively healthy natural environment, poor kitchen ventilation, physical of house, and behavior cause serious indoor air pollution. The

low air quality (due to pathogens, PM_{2.5}, and chemical compounds) was trapped in the kitchen room and exposed children for a long time and repeatedly. This condition is indicated by the fact that 90.9% of under-five children with airway disease came from families using wood fuel, and 95.5% of them were held during cooking activities.

CONCLUSION

This study found that upper airway disease occurrence of 69.4% with the associated risk factors was the poor quality of walls and floor, kitchen ventilation, the use of wood fuel, and holding a child while cooking simultaneously. Further study is necessary conducted to understand the occurrence and risk factors of severe lower airway disease or pneumonia among under-five children.

Conflict of interest: Nil

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