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Adapun penelitian tersebut layak dilakukan dan menghasilkan output yang sangat baik, meskipun belum ada ***Uji Ethical Clearance*** karena merupakan penelitian menggunakan metode **Systematic Review**.

Demikian surat keterangan ini kami buat untuk dapat dipergunakan sebagai persyaratan pengusulan Jabatan Fungsional Guru Besar.

Surabaya, 24 April 2023
Dekan,

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NIP 196609271997022001

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Acute Respiratory Infections Associated with Exposure to Biomass Cooking Fuels and Cigarette Smoke among Children Under Five Years of Age in Developing Countries

Leka Lutpiatina[1, 2], Lilis Sulistyorini[3], Hari Basuki Notobroto[4] and Isnawati[5C]

[1]Doctoral Program of Public Health, Faculty of Public Health, Campus C Universitas Airlangga, Jalan Mulyosari, Surabaya, Indonesia
[2]Medical Laboratory Technology Poltekkes Kemenkes Banjarmasin, Jalan Mistar Cokrokusumo 4a Banjarbaru, Indonesia
[3]Department of Environmental Health, Faculty of Public Health, Campus C Universitas Airlangga, Jalan Mulyosari, Surabaya, Indonesia
[4]Department of Biostatistics and Population, Faculty of Public Health, Campus C Universitas Airlangga, Jalan Mulyosari, Surabaya, Indonesia
[5]Environmental Health Department Poltekkes Kemenkes Banjarmasin, Jalan Mistar Cokrokusumo 1a Banjarbaru, Indonesia
E-mail: [3]<l.sulistyorini@fkm.unair.ac.id>

KEYWORDS Child Health Morbidity. Environmental Risk. Poor Country. Second-hand Smoke. Wood Fuel

ABSTRACT Exposure to household air pollution is an environmental risk factor associated with respiratory disease, especially in children in developing countries. The primary sources of indoor air pollution in households are cooking fuels and cigarette smoke. The purpose of this study was to systematically review scientific articles related to the risk factors of biomass cooking fuel and smoking family members on the incidence of Acute Respiratory Infections in children under five years in developing countries. This systematic search was carried out following the Prisma protocol by collecting research data found in the Pubmed, Scielo, Lilacs and Google Scholar databases. The data are categorised by country name, the number of children under five years studied, data design, analytical method, and odds ratio (95% CI) of biomass cooking fuel and family smoking. As a result, 17 articles were selected for review, and all studies applied logistic regression to estimate the risk, except for one study that used the Poisson regression model. The range of risk factors for cooking fuel biomass Odds Ratio (95% CI) was 1.10 (1.01–1.20) to 4.348 (1.632, 11.580), the risk factor for family members smoking was 1.06 (1.00–1.12) to 3.58 (1.45-8.84). Research conclusions were that risk factors for biomass fuel for cooking and family members smoking tobacco are determinants of Acute Respiratory Infections or ARI in children under five years in developing countries. The risk factor for biomass fuel has a higher probability of causing ARI than family members who smoke tobacco. Suggestions for parents included, to pay special attention to children by keeping children away from cooking fuel fumes and not smoking indoors. Governments in developing countries should pursue effective strategies to increase access to clean fuels to reduce exposure to indoor air pollution.

INTRODUCTION

The purpose of this study was to systematically review scientific articles related to the risk factors of biomass cooking fuel and smoking family members on the incidence of ARI in children under five in developing countries

Acute Respiratory Infection (ARI) is one of the most common and harmful diseases in children under five years old, and this disease mainly affects children with high exposure to air pollutants (Sly and Flack 2008). WHO explains that respiratory infections due to indoor air pollution cause death globally in 7 million people (WHO 2018). While in South Asia, indoor air pollution is the third leading cause of respiratory disease (Devakumar et al. 2014). Sources of indoor air pollution can come from the combustion process for cooking, human activities such as smoking, biological agents, and the use of chemicals in ingredients used to build buildings (Pérez-Padilla et al. 2010). Respiratory diseases in children such as rhinitis, asthma, and respiratory tract infections have an increased incidence of disease when exposed to indoor tobacco smoke (Zhuge et al. 2020). In developing countries, cases of lower respiratory infections in children have been associated with exposure to indoor air pollution (Barnes et al. 2005; Savitha et al. 2007). Exposure to household air pollution is an environmental risk factor associated with respiratory disease, especially in children, in developing countries (Liu F et al. 2014; Taylor and Nakai 2012).

The primary source of indoor air pollution is biomass fuel, which can cause illness and death from acute respiratory infections in children (Azad et al. 2014; Taksande and Yeole 2015). It is estimated that half of the world's population uses biomass as an energy source, as they are mainly in rural areas of poor or developing countries (Laumbach and Kipen 2012). Biomass material is a low-efficiency fuel (Chakraborty et al. 2014). Biomass materials produce incomplete combustion products with relatively high harmful health effects (Fullerton et al. 2008). It is a significant risk factor for acute respiratory infections (Desalegn et al. 2011). The results of this meta-analysis showed that children were three times more likely to develop ARI when exposed to biomass fuels compared to alternative fuels (OR 3.53, 95% CI 1.94-6.43) (Po et al. 2011).

In addition to biomass fuel, cigarette smoke is another source of indoor air pollution. Indoor cigarette smoke increases ARI risk in toddlers and is statistically significant (Hidayanti et al. 2019). The results showed that smoking behaviour was related to ARI incidence in toddlers (Mahendrayasa and Farapti 2018). Research by Tazinya et al. (2018) concluded that toddlers whose families smoke are at greater risk of developing ARI than those who do not smoke. The research of Choube et al. (2014) stated that family members who smoke indoors significantly affect the incidence of ARI in toddlers. Toddlers as passive smokers are even three times more likely to experience ARI (OR: 3.58, 95% Cl: 1.45–8.84) (Tazinya et al. 2018). The possibility of exposure to cigarette smoke is at greater risk for children because they are still weak with their immune system.

Research on environmental risk factors for the incidence of ARI in toddlers has been done a lot, but the research that collects two important risk factors for the occurrence of ARI in toddlers, namely, the cooking fuel factor and smoking family members are rarely found, even though this is an essential factor that has very dominant influence on the occurrence of ARI in children under five. The purpose of this study was to systematically review scientific articles related to the risk factors of biomass cooking fuel and smoking family members on the incidence of ARI in children under five in developing countries.

MATERIAL AND METHODS

A systematic review was conducted throughout October, November and December 2021. This systematic search was carried out following the Prisma protocol (Moher et al. 2009) by collecting research data found in the Pubmed, Scielo, Lilacs, and Google Scholar databases, published until 23/12/2021. The elements that focus on this review included children, acute respiratory infections, solid cooking fuels/biomass and smoking.

Selection Criteria

Eligible studies must measure the association of environmental risk factors with respiratory infections in children under five years, including risk factors of cooking fuel and family members smoking. Articles have been published in the last ten years from peer-reviewed journals.

Exclusion Criteria Review

Literature reviews, and articles other than English or Indonesian (author's language proficiency) were excluded from the systematic review.

Synthesis Analysis

Data were categorised by country name, the number of children under five years studied, data design, analytical method, and odds ratio (95% CI) of biomass cooking fuel and family smoking.

Two independent researchers conducted a literature search and article selection process. Differences were discussed with the third and fourth investigators until consensus was reached. Data extraction and synthesis were carried out between December 2021 and January 2022.

RESULTS AND DISCUSSION

A total of 2,482 articles were identified in the systematic search. After excluding duplicates and screening of titles and abstracts, 137 articles were eligible for full-text reading. A total of 17 articles were selected for review after eliminating some articles that did not include environmental risk factors, cooking fuels, and smoking family members, as well as studies in children not in developing countries (Fig.1).

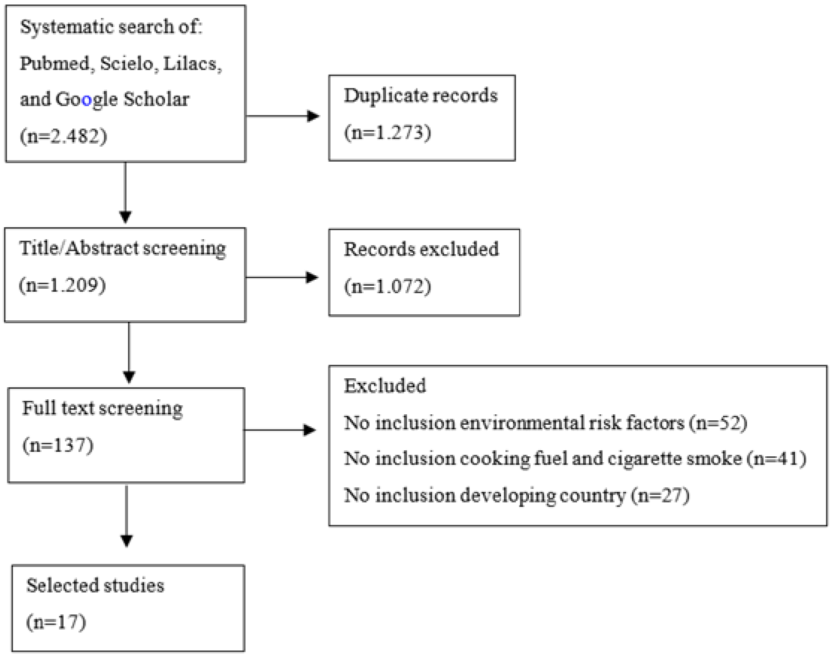

Fig. 1. Retrieval flowchart and selection of articles

All selected articles (Table 1) were published between 2013 and 2021, with the last publication date of 23rd December 2021. Two studies were conducted in Cameroon (Tazinya et al. 2018; Marius et al. 2019), two studies in Nigeria (Adesanya and Chiao 2017; Akinyemi and Morakinyo 2018), two studies in Afghanistan (Rayhan et al. 2019; Rana et al. 2019), three studies in Ethiopia (Sanbata et al. 2014; Admasie et al. 2018; Addisu et al. 2021), four studies in India (Sharma et al. 2013; Ashwani and Kalosona 2016; Mondal and Paul 2020; Mandal et al. 2020), and one study each was in Zambia (Mulambya et al. 2020), Bangladesh (Hasan et al. 2019), Nepal (Acharya et al. 2015) and Brazil (Cardoso et al. 2013). All studies applies logistic regression to estimate the magnitude of risk, except for one study that uses the Poisson regression model (Rana et al. 2019).

Of the 17 research articles reviewed; as many as 7 studies using primary data (direct data collection) on children. The range of the number of respondents is 101-512 children, the research design is cross sectional (4 studies), and case controls (3 studies). A total of 10 other studies used secondary data, namely Demographic and Health (DHS) data; 6, National Family Health Survey (NFHS); 3, and the Urban Health Survey; 1. The range of risk factors for cooking fuel biomass Odds Ratio (95% CI) is 1.10 (1.01–1.20) to 4.348 (1.632, 11.580), while the risk factor for smoking family members is 1.06 (1.00–1.12) to 3.58 (1.45-8.84).

The risk factor for biomass cooking fuel with the highest odds ratio (95% CI) (4,348; 95% CI: 1,632, 11,580) was found in the study of Addisu et al. (2021). This study involved 265 Ethiopian children under five, with 67.5 percent living in households that use biomass fuel. Meanwhile, the risk factor for family members smoking with the highest odds ratio (95% CI) (3.58; 95% Cl: 1.45–8.84) was found in the study of Tazinya et al. (2018). This study involved 512 Cameroonian toddlers, with 83.78 percent living in households where family members smoke.

The risk factor for biomass cooking fuel has a higher Odds Ratio than the risk factor for smoking family members in all studies, except in the study of Admasie et al. (2018), namely biomass cooking fuel with 2.09 (1.29-3.39), family members smoke with 3.08 (1.32-7.18), and research Mandal et al. (2020) biomass cooking fuel with 1.03 (0.86-1.08), and smoking family members with 1.42 (1.18-1.70).

Based on the findings of this study, there is a strong relationship between biomass fuel and smoking family members on the prevalence of ARI in children under five. Combustion of biomass and cigarette smoke can cause high particulates in the room's air where toddlers live. Research shows a significantly higher concentration of particulates among households using biomass fuels (Addisu et al. 2021). Studies in India show that biomass fuels result in higher indoor particulate concentrations than clean fuels (Balakrishnan et al. 2014). Meanwhile, research in Sri Lanka showed that houses using biomass fuel for cooking had higher concentrations of PM ($p < 0.001$) compared to homes using LPG and electricity (Ranathunga et al. 2019). Biomass fuel has a low combustion rate but causes significant emissions of air pollution that is detrimental to health (Sanbata et al. 2014).

Households in developing countries often choose solid fuels such as wood, crop residues, and charcoal compared to developed countries that use clean fuels (Toole 2015). Biomass fuel is used to meet the energy needs of households in sub-Saharan Africa as much as seventy-seven percent, as this fuel is used primarily for cooking and household heating (Fakunle et al. 2017).

Exposure to biomass fuels is associated with many respiratory tract diseases such as acute respiratory infections, chronic obstructive pulmonary disease, lung cancer, pulmonary tuberculosis, and asthma (Prasad et al. 2012). Exposure to biomass smoke from traditional stoves is one of the factors causing acute respiratory infections in young children (Admasie et al. 2018). Acute respiratory infections are the most common cause of illness and death in children under five, with 2 million deaths worldwide (Ranathunga et al. 2019). In developing countries, exposure to burning biomass fuels has increased the incidence of acute respiratory infections in children under five years of age (Balakrishnan et al. 2014).

Research conducted in southern Ethiopia shows that sixty-six percent of households depend on biomass fuels in the form of charcoal, firewood and kerosene (Admasie et al. 2018). Research results from the Ethiopian Demographic and Health Survey found that ninety-three percent of households in Ethiopia use some solid fuel for cooking with wood (EDHS 2016). The high use of biomass may be an implication of its ease of availability and lower costs compared to cleaner fuels (Buba et al. 2017). Large households prefer cheaper fuels than clean fuels, which are rarely affordable for their household energy sources (Soltani et al. 2019).

Exposure to cigarette smoke and cigarette smoke is very harmful to human health. Tobacco smoke contains more than 7000 chemical components, among which several are toxic, such as aldehydes nitrides that irritate the respiratory tract, nicotine that causes tobacco addiction, benzpyrene, arsenic and cadmium have a carcinogenic effect, and nitric oxide reduces oxygen transport by erythrocytes (Jiang et al. 2020).

Harmful substances in cigarette smoke can facilitate the invasion of pathogenic organisms and increase susceptibility to infection by disrupting the structure and function of the respiratory tract, oral environment, and digestive tract (Jiang et al. 2020). The epithelium of the respiratory tract is the first line of defence against inhaled pollutants and pathogens. Cigarette smoke can directly damage the airway epithelial barrier, damage ciliated cells, goblet cells, basal cells, and sub-mucosal secretory glands (Aghapour et al. 2018). Toxic substances in cigarette smoke can interfere with causing mucus hyper-secretion (Maestrelli et al. 2001). Cigarette smoke interferes with the metabolism of human respiratory basal tract stem cells (Deeb et al. 2016), impairing the integrity of the airway epithelium, especially by impaired cell-to-cell contact (Heijink et al. 2012).

Reactive Oxygen Species (ROS) in cigarette smoke interferes with mitochondrial function in airway epithelial cells by decreasing the ability of mitochondria to synthesise ATP. Mitochondrial dysfunction causes cellular necrosis and progressive inflammation in the lung, promoting tissue remodelling and susceptibility to infection (Lerner et al. 2016; Zhang et al. 2017). Free radicals in large quantities in cigarette smoke can damage the integrity of the respiratory tract and alveolar epithelial cells, thereby increasing the likelihood of infection. Lee et al. (2010) found that rats exposed to cigarette smoke had faster influenza virus proliferation and higher viral loads. Smoking in the mother can cause fatigue of foetal respiratory movements in the womb, interfere with foetal respiratory function, and decrease respiratory defence function (Jiang et al. 2020). The fact that smoking impairs the natural protective mechanisms of the respiratory tract makes it easier for pathogens to over-

Table 1: Characteristics of studies selected in the review

No.	Author (Year)	Country	Number of children under five years studied	Data design (Year)	Analytical method	Odds ratio (95 % CI)	
						Biomass cooking fuel	Family smoking
1	Cardoso et al. (2013)	Brazil	321	Case-control 2007-2008	Logistic regression	3,08 (1,39-6,84)	
2	Sharma et al. (2013)	India	500	Case control 2009-2010	Logistic regression	2.65 (1.71-4.10)	1.52 (1.00-2.30)
3	Sanbata et al. (2014)	Ethiopia	422	Cross-sectional 2012	Logistic regression	3.98 (1.88, 8.24)	1.96 (1.10,3.49)
4	Acharya et al. (2015)	Nepal	4.802	Demographic and Health Survey (DHS) 2011	Logistic regression	1.46 (0.94, 2.26)	
5	Ashwani and Kalosona (2016)	India	52.868	National Family Health Survey (NFHS-I), 1992-93(NFHS-II), 1998-99 (NFHS-III), 2005-06	Logistic regression models	1.30 (1.0 5-1.40)	1.25 (1.11-1.42)
6	Adesanya and Chiao (2017)	Nigeria	28.596	Demographic and Health Survey (DHS) 2013	Logistic regression	2.38 (1.34-4.24)	1.37 (1.01-1.87)
7	Tazinya et al. (2018)	Kamerun	512	Cross-sectional 2014-2015	Logistic regression		3,58 (1,45-8,84)
8	Admasie et al. (2018)	Ethiopia	17.421	Case control, 2017	Logistic regression	2.09 (1.29-3.39)	3.08 (1.32-7.18)
9	Akinyemi and Morakinyo (2018)	Nigeria	28.950	Demographic and Health Survey (DHS) 2013	Logistic regression	2.50 (1.16-5.42)	1.20 (0.89-1.61)
10	Rana J et al. (2019)	Afghanistan	27,565	Demographic and Health Survey (DHS) 2015	Poisson regression model	(aPR) =1.10 (0.98-1.23)	
11	Hasan et al. (2019)	Bangladesh	10.575	Bangladesh Urban Health Survey 2013	Logistic regression	1.18 (1.04-1.36)	
12	Marius et al. (2019)	Cameroon	101	Cross sectional, 2016	Logistic regression	1.44 (1.21-1.92)	
13	Rayhan et al. (2019)	Afghanistan	31.063	Demographic and Health Survey (DHS) 2015	Logistic regression	1.13 (0.92-1.39)	
14	Mondal and Paul (2020)	India	247.743	National Family Health Survey-4 . (NFHS-4), 2015-16	Logistic regression	1.10 (1.01-1.20)	1.06 (1.00-1.12)
15	Mulambya et al. (2020)	Zambia	30.391	Demographic and Health Survey (DHS) 1996, 2002, 2007, 2014	Logistic regression	2.67 (2.09 - 3.42)	
16	Mandal et al. (2020)	India	247.743	National Family Health Survey (NFHS-IV), 2015-16	Logistic regression models	1.03 (0.86-1.08)	1.42 (1.18-1.70)
17	Addisu et al. (2021)	Ethiopia	265	Cross-sectional, 2020	Logistic regression	4.348 (1.632, 11.580)	2.224 (1.72, 12.58)

come first-line defence of the respiratory system (Valencia-Gattas et al. 2016). Anti-smoking campaigns are needed to help make people aware of the dangers of cigarette smoke for health, especially for children (Tazinya et al. 2018).

The risk factor for biomass cooking fuel has a higher Odds Ratio than the risk factor for smoking family members (Table 1), so this shows that the risk factor for biomass cooking fuel plays a more important role in causing ARI in toddlers. According to Addisu et al. (2021), the concentration of particulates the highest percentage is found in households using biomass fuel. When compared with particulates from cigarette smoke, the possibility is less so that the effect of using biomass as a cooking fuel is more significant.

CONCLUSION

Risk factors for using biomass fuel for cooking and family members smoking tobacco are determinants of ARI in children under five years of age in developing countries. The risk factor of using biomass fuel for cooking has a higher probability of causing ARI than the factor of family members smoking tobacco.

RECOMMENDATIONS

Particular attention should be paid to children in developing countries so that parents keep their children away from cooking fuel fumes and do not smoke indoors. The government should pursue effective strategies to increase access to clean fuels to reduce exposure to indoor air pollution.

LIMITATIONS

The limitation of this study is the variation in the number of children under five in each study. Studies with primary data only amounted to hundreds. Still, research with secondary data, the number of under-fives studied amounted to tens of thousands, thus affecting the validity of the results of each study. In addition, the sampling method of the analysis was not all case-control, making it impossible to make a critical assessment of the risk of bias using the Newcastle Ottawa Scale (NOS).

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