

A Meta-Analysis of the Effects of Secondhand Smoke Exposure toward the Incidence of Pneumonia in Children Under Five

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ABSTRACT

Background: Pneumonia is an acute respiratory infection in which the alveoli are filled with pus and fluids that cause painful respiration and limit oxygen intake. Pneumonia is the main cause of death among children under five in the world, killing more than 800,000 children under five each year, or about 2,200 per day. One of the risk factors for pneumonia in children under five is exposure to secondhand smoke. This study aimed to estimate the magnitude of the effect of exposure to secondhand smoke on the incidence of pneumonia in children under five.

Subjects and Method: This study used a systematic review and meta-analysis technique. There were three article search databases including Google Scholar, Pubmed, and Science Direct with a publication period from 2009-2020. The article search was carried out by considering the eligibility criteria defined using the PICO model. P: children under five, I: exposed to secondhand smoke, C: not exposed to secondhand smoke, and O: pneumonia. The keywords for searching the articles were (risk factors OR passive smoking OR secondhand smoking) AND (pneumonia) AND (children under five). The articles included in this study were full-text articles, articles in English, arti-

cles with cross-sectional study design and case-control, articles with adjusted odds ratio results. Articles were collected using PRISMA flow diagrams and analyzed using RevMan 5.3 application.

Results: The total of 12 articles were reviewed in this study. A meta-analysis of three cross-sectional studies showed that exposure to secondhand smoke increased the risk of pneumonia in children under five (aOR= 1.66; 95% CI= 1.38 to 2.01; p <0.001). A meta-analysis of nine case-control studies showed that exposure to secondhand smoke increased the risk of pneumonia in children under five years (aOR= 2.15; 95% CI=1.25 to 3.68; p=0.005).

Conclusion: Exposure to secondhand smoke increases the incidence of pneumonia in children under five.

Keywords: The exposure to secondhand smoke, pneumonia, children under five.

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BACKGROUND

Smoking is one of the habits that commonly found in everyday life, especially by Indonesians. Based on worldwide data, Indonesia ranked seventh as a country with a prevalence of 39.5% of adult tobacco smo-

kers aged ≥ 15 years (WHO, 2018). Then, Indonesia ranked first in ASEAN countries with a prevalence of 36.3% (Lian and Dorothéo, 2019).

Whereas in Indonesia itself, the prevalence of smokers in the population aged \geq

15 years from year to the year continued to increase, in 2015 it was 30.08%, decreased in 2016 by 28.97%, then increased again in 2017 by 29.25% and in the end in 2018 it was 32.20% (BPS, 2018). Meanwhile, the minister of health had set a target of reducing the prevalence of smokers in 2015-2019 by 1% per year (Kemenkes RI, 2013). Certainly, it did not meet the target that had been set. Therefore, the problem of cigarette consumption still becomes a national problem which is being pursued until now.

The problem of cigarette consumption not only causes a health burden for the smoker himself (active smokers) but also for other people around them who do not smoke (passive smokers). Health experts stated that because there is a filter on the tip of the cigarette, from 100% of the dangers of cigarette smoke, only 25% is felt by active smokers, while the remaining 75% is obtained by passive smokers, due to direct exposure to secondhand smoke (Kemenkes RI, 2018).

Secondhand smoke inhaled by passive smokers had at least 4000 chemical compounds and 250 harmful substances such as cyanide, tar, arsenic, benzene, and various other harmful substances (WHO, 2011). Certainly, the most susceptible to becoming passive smokers are children under five. It is because children under five spend more time at home and their immune systems have not been fully formed so that if there are family members who are active smokers, the child will automatically become passive smokers (CDC, 2018). Therefore, children under five are very susceptible affected by viruses and bacteria that can cause disease, one of which is pneumonia.

Pneumonia is an acute respiratory infection in which the alveoli are filled with pus and fluids that cause painful respiration and limit oxygen intake (WHO, 2019).

Pneumonia was an infectious disease that became the main cause of death among children under five in the world, killing more than 800,000 children under five every year or about 2,200 per day. Pneumonia is also the main cause of death for children under five in Indonesia. In 2018, an estimated 19,000 children died from pneumonia and global estimates indicated that every hour 71 children in Indonesia contracted pneumonia (UNICEF, 2019).

One of the main factors causing the incidence of pneumonia in children under five is frequent exposure to secondhand smoke. Based on a study conducted by Suzuki et al. (2009), having family members who were active smokers had a 1.53 times risk for children under five of experiencing pneumonia compared to the family without active smokers. Likewise, a study conducted by Adane et al. (2020) showed that children under five who were passive smokers had a 2.11 times risk of developing pneumonia compared to toddlers who were not passive smokers. From the two primary studies above, it is understood that exposure to secondhand smoke increases the risk of pneumonia in children under five.

Many primary studies examining the effect of secondhand smoke exposure on the incidence of pneumonia in children under five had encouraged the researchers to conduct more comprehensive studies of these primary studies. The data obtained will be analyzed using a systematic review and meta-analysis by synthesizing the results of studies conducted to reduce bias.

SUBJECTS AND METHOD

1. Study Design

This was a systematic review and meta-analysis study. The articles used in this study were obtained from several databases including PubMed, Google Scholar, and Science Direct. The keywords for finding articles

were risk factors OR passive smoking OR secondhand smoking) AND (pneumonia) AND (children under five).

2. Inclusion Criteria

The Articles included in this study should be full paper, used cross-sectional and case-control study, and used English. The article should be appropriate in which the independent variable exposure to secondhand smoke was tested on the dependent variable pneumonia in children under five years, the test was based on multivariate analysis of adjusted Odss Ratio.

3. Exclusion Criteria

The articles published in this study were not in English and the results were not adjusted Odss Ratio. The number of study samples was (n <100).

4. Operational Definition of Variables

The article search was carried out by considering the eligibility criteria defined using the PICO model. The population in the study was children under five with inter-

vention in the form of exposure to secondhand smoke, the comparison was not exposed to secondhand smoke and the outcome was pneumonia.

Secondhand smoke exposure was the presence of family members who become active smokers and smoked in the house. Pneumonia is an acute respiratory infection in which the alveoli are filled with pus and fluids that make painful respiration and limit oxygen intake.

5. Data Analysis

The data processing was carried out by the Review Manager (RevMan 5.3) by calculating the effect size and heterogeneity to determine which research models were combined and formed the final meta-analysis result.

RESULTS

The article review process can be seen in the PRISMA flow diagram in Figure 1.

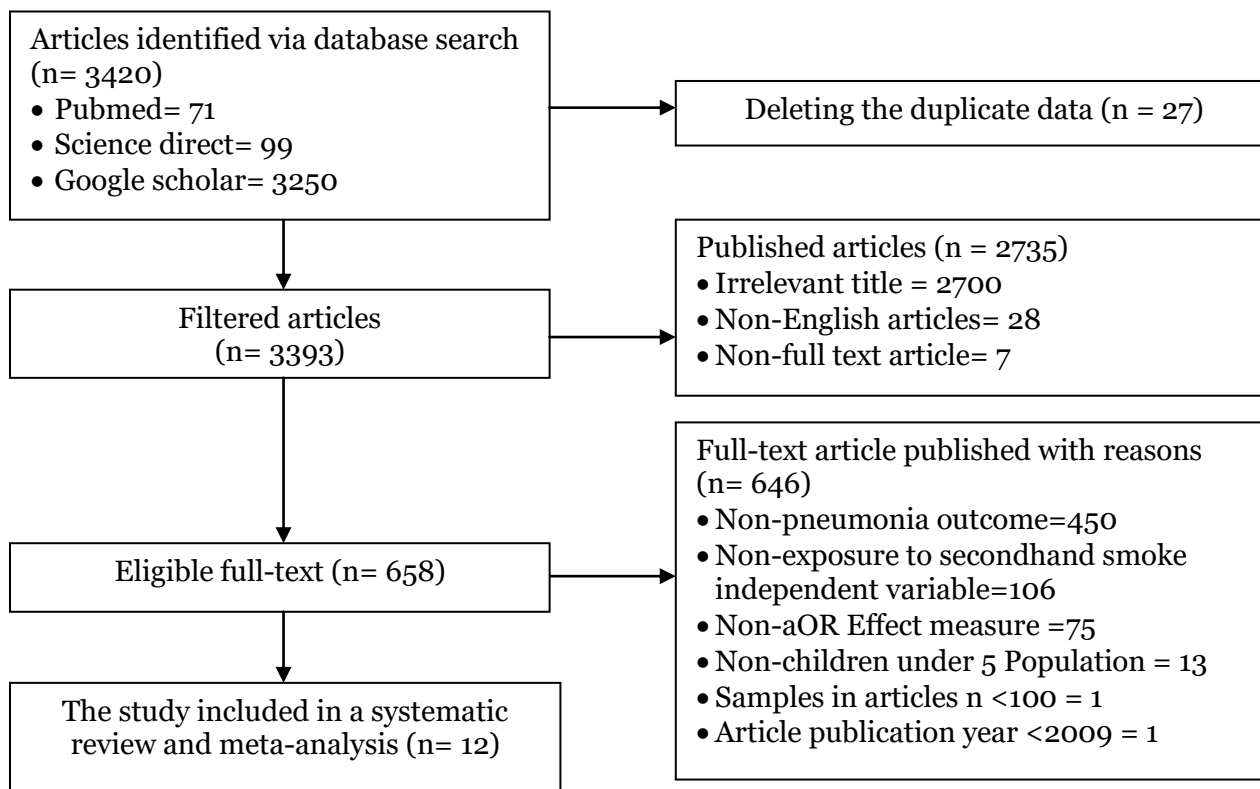


Figure 1. PRISMA Flow Diagram

This meta-analysis analyzed 12 primary studies conducted on 4 continents, namely the African Continent (Tanzania, Ethiopia, and Morocco), the South American Continent (Brazil), the Asian Continent (Indonesia, Bangladesh, Nepal, and Vietnam), and the Australian Continent (New Zealand).

Assessment of the quality of primary studies was carried out quantitatively and qualitatively which can be seen in Table 1 and Table 2. This study used the Critical Appraisal Checklist for Cross-Sectional Study and the Critical Appraisal Checklist for Case-Control Study from the Center for Evidence-Based Management (CEBMA, 2014).

Table 1. Quality Assessment of Pneumonia Articles: Cross-Sectional

Primary Studies	Criteria												Total	
	1	2	3	4	5	6	7	8	9	10	11	12		
Adane et al. (2020)	1	1	1	0	1	1	1	1	1	1	1	1	1	11
Jroundi et al. (2014)	1	1	0	1	1	1	1	1	1	1	1	1	1	11
Suzuki et al. (2015)	1	1	1	0	1	0	1	1	1	1	1	1	1	10

Answer : 1= Yes and 0= No

Table 2. Quality Assessment of Pneumonia Articles: Case-Control

Primary Studies	Criteria												Total
	1	2	3	4	5	6	7	8	9	10	11	12	
Geleta et al. (2016)	1	1	1	1	1	1	1	1	1	1	0	1	11
Grant et al. (2012)	1	1	1	1	1	0	1	1	1	1	0	1	10
Hoang et al. (2019)	1	1	1	1	1	1	1	1	1	1	0	1	11
Karki et al. (2014)	1	1	1	1	1	0	1	1	1	1	0	1	10
Lima et al. (2016)	1	1	1	1	1	1	1	1	1	1	0	1	11
Luthfiyana et al. (2018)	1	1	1	1	1	1	1	1	1	1	0	1	11
Ngocho et al. (2019)	1	1	1	1	1	0	1	1	1	1	0	1	10
Uddin et al. (2013)	1	1	1	1	1	0	1	1	1	1	0	1	10
Yunita et al. (2016)	1	1	1	1	1	0	1	1	1	1	0	1	10

Answer: 1= Yes and 0= No

Based on the assessment of the quality of the primary articles above, the score for the quality of the articles was 10 to 11. This indicated that the articles had a good quality for meta-analysis (CEBMA, 2014).

A summary of the primary articles used for the meta-analysis of the effect of exposure to tobacco smoke on the incidence of pneumonia can be seen in Table 3.

Table 3. The descriptions of the Primary study that were included in the meta-analysis

Author (year)	Country (Continent)	Study Design	Sample	P (Population)	I (Intervention)	C (Comparison)	O (Outcome)
Grant et al. (2011)	New Zealand (Australia)	Case Control	856	Children under five	Tobacco smoking family members	Non-tobacco smoking family members	Pneumonia
Lima et al. (2016)	Brazil (South America)	Case Control	814	Children under five	Smoking mothers	Non-smoking mothers (active or passive)	Pneumonia
Ngoco et al. (2019)	Tanzania (Africa)	Case Control	463	Children under five	Smoking parents	Non-smoking parents	Pneumonia
Geleta et al. (2016)	Ethiopia (Africa)	Case Control	382	Children under five	Smoking parents	Non-smoking parents	Pneumonia
Yunita et al. (2016)	Indonesia (Asia)	Case Control	140	Children under five	Smoking parents	Non-smoking parents	Pneumonia
Uddin et al. (2013)	Bangladesh (Asia)	Case Control	192	Children aged 2-12 months	Smoking parents in the house	Non-smoking parents in the house	Pneumonia
Luthfiyana et al. (2018)	Indonesia (Asia)	Case Control	200	Children under five	Exposed to secondhand smoke	Not exposed to secondhand smoke	Pneumonia
Karki et al. (2014)	Nepal (Asia)	Case Control	200	Children under five	Smoking fathers	Non-smoking fathers	Pneumonia
Hoang et al. (2019)	Vietnam (Asia)	Case Control	166	Children under five	Tobacco smoking family members	Non-tobacco smoking family members	Pneumonia
Jroundi et al. (2014)	Morocco (Africa)	Cross Sectional	689	Children under five	Smoking parents in the house	Non-smoking parents in the house	Pneumonia
Adane et al. (2020)	Ethiopia (Africa)	Cross Sectional	5830	Children under four	Passive smokers	Free secondhand smoke	Pneumonia
Suzuki et al. (2015)	Vietnam (Asia)	Cross Sectional	24781	Children under five	Smoking parents	Non-smoking parents	Pneumonia

A. Forest Plot

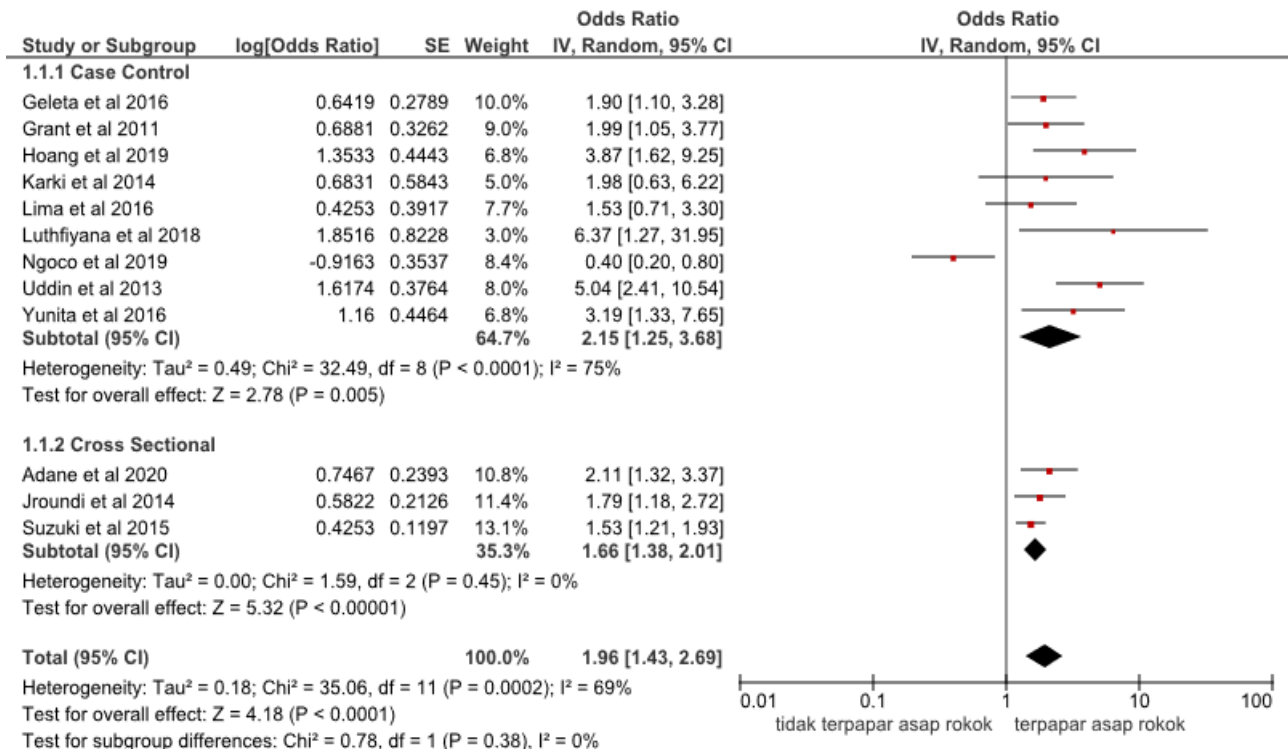


Figure 2. Forest plot the effect of secondhand smoke exposure on the incidence of pneumonia in children under 5

B. Funnel Plot

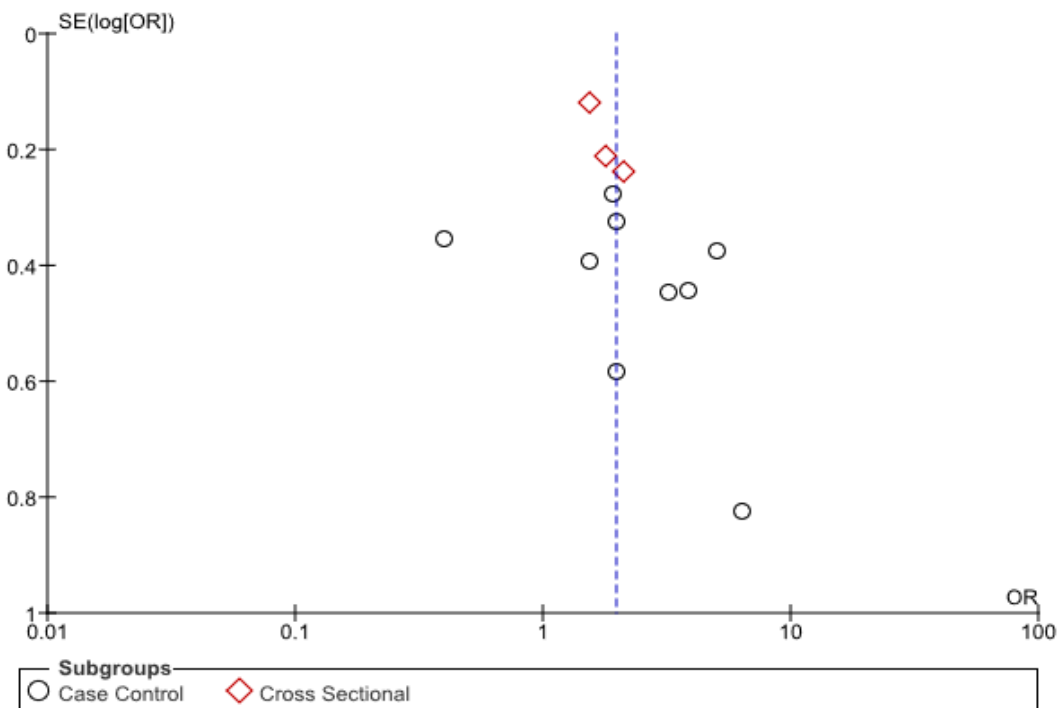


Figure 3. Funnel plot of the effect of exposure to tobacco smoke toward the incidence of pneumonia in children under 5

Based on the results of the forest plot (Figure 2) in a cross-sectional study, children under five who were exposed to tobacco smoke had a 1.66 times risk of developing pneumonia compared to children under five who were not exposed to tobacco smoke and it was statistically significant ($p < 0.001$). The heterogeneity of the research data showed $I^2 = 0\%$. Whereas in a case control study children under five who were exposed to tobacco smoke had a risk of developing pneumonia 2.15 times compared to children under five who were not exposed to tobacco smoke and it was statistically significant ($p = 0.005$). The heterogeneity of the research data showed $I^2 = 75\%$. So that the distribution of data was declared as heterogeneous (random effect model).

The funnel plot (Figure 3) shows a publication bias which is characterized by the asymmetry of the right and left plots where 4 plots are on the right side and 3 plots are on the left side. The plot on the right side of the graph appears to have a standard error between 0.2 and 0.8, while the plot on the left has a standard error between 0 and 0.4.

DISCUSSION

This systematic review and meta-analysis study raised the theme of the effect of secondhand smoke exposure on the incidence of pneumonia in children under five years. This meta-analysis study used the research sources that controlled for confounding factors or confounding factors which could be seen from the study inclusion requirements namely multivariate analysis, and the statistical results reported were adjusted odds ratio (aOR). The combined results of the effect of secondhand smoke exposure on the incidence of pneumonia in children under five years were processed using the RevMan 5.3 applica-

tion, while the results of a systematic study and meta-analysis were presented in the form of a forest plot and a funnel plot.

Secondhand smoke exposure to the incidence of pneumonia in children under 5

The results of the forest plot in this meta-analysis used subgroup analysis based on the study design. The results of the meta-analysis of cross-sectional studies showed that children under five who were exposed to secondhand smoke had a 1.66 times risk of having pneumonia than children under five who were not exposed to secondhand smoke. The results of the meta-analysis of a case-control study showed that children under five who were exposed to secondhand smoke had a 2.15 times risk of having pneumonia compared to children under five who were not exposed to secondhand smoke.

This study is in line with a study conducted by Mustikarini et al. (2019) that children under five whose family members were smokers had a 1.39 risk of experiencing pneumonia compared to children under five whose family members were not smokers ($b = 1.39$; 95% CI = 0.46 to 2.32; $p = 0.003$).

Alnur et al. (2017), also stated that children under five years who had family members as smokers had a 2.35 times risk of having pneumonia compared to children under five years whose family members were not smokers (aOR = 2.35; 95% CI = 1.15 to 4.79; $p = 0.019$).

Too often exposed to secondhand smoke is understood to decrease the ability of macrophages to kill bacteria. The process of macrophages in killing bacteria is called phagocytosis. Macrophages are mostly found in the alveoli and will be mobilized to other places when there is an infection. There was a study that tested cells exposed to cigarette smoke extracts with glucocor-

ticoids, an anti-inflammatory that is commonly used to treat respiratory conditions. The results showed that the drug did not guarantee recovery from the inhibition of the phagocytosis process of alveolar macrophages caused by cigarette smoke so that if exposed for too long could cause the incidence of pneumonia (Kusumawati, 2010).

As what have known, because there is a filter at the end of the cigarette, from 100% of the dangers of cigarette smoke, only 25% is felt by active smokers, while the remaining 75% is obtained by passive smokers due to direct exposure to secondhand smoke (Kemenkes RI, 2018).

Secondhand smoke inhaled by passive smokers had at least 4000 chemical compounds and 250 harmful substances such as cyanide, tar, arsenic, benzene, and various other harmful substances (WHO, 2011).

Children under five automatically became passive smokers if there were family members who smoked in the house. Because children under five had not fully developed their immune system so that if the child was often exposed to secondhand smoke, it was certain that the children were very susceptible to suffer from viruses or bacteria that caused pneumonia.

The limitation in this study was a publication bias that was shown in the funnel plot, language bias occurred because this study only selected articles published in English so it ignored articles that used other languages, and search bias because in this study the researchers only used 3 databases (PubMed, Science Direct and Google Scholar) thus ignoring other search sources.

AUTHOR CONTRIBUTION

Maya was the main researcher who selected topics, searched, and collected the research data. Setyo Sri Rahardjo and Bhisma Murti

played a role in analyzing data and reviewing research documents.

CONFLICT OF INTEREST

There is no conflict of interest.

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