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Meta-analysis

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Meta-Analysis: Effects of Exposure to Tobacco Smoke and Malnutrition on the Risk of Pneumonia in Children

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ABSTRACT

Background: Exposure to tobacco smoke (ETS) and poor nutritional status affect the risk of pneumonia in children. The purpose of this study was to analyze and estimate the effect of exposure to tobacco smoke and nutritional status in children on the risk of pneumonia.
Subjects and Method: The meta-analysis was carried out using the PRISMA flowchart and the PICO model. Population: children under five. Intervention: exposure to tobacco smoke and poor nutritional status. Comparison: no exposure to tobacco smoke and no malnutrition status. Outcome: Pneumonia. The online databases used are Google Scholar, PubMed, and Scient Direct with the keywords "Pneumonia" AND "Exposure to tobacco smoke" AND "Poor nutritional status" AND "Children under five years" AND "Multivariate" AND "Cross-sectional". The inclusion criteria were full-text, cross-sectional study, and published in English. The data were analyzed by RevMan 5.3.
Results: A meta-analysis included 14 cross-sectional studies from Hong Kong, Nepal, Mongolia, Morocco, Uganda, Cameroon, Ethiopia, Nigeria, Egypt, and China. The total sample was 52,863 children under five. The results of the meta-analysis showed that exposure to tobacco smoke was 2.08 times more at risk of developing pneumonia than children under five who were not exposed (aOR=2.08; Cl 95%=1.30 to 3.32; p= 0.002). The presence of poor nutritional status is 2.00 times more at risk of experiencing pneumonia than children under five with no malnutrition status. (aOR=2.00; 95% Cl=1.31 to 3.06; p= 0.001).
Conclusion: Exposure to tobacco smoke and poor nutritional status in toddlers can increase the risk of pneumonia.

Keywords: exposure to tobacco smoke, poor nutritional status, children under five years pneumonia.

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BACKGROUND

Exposure to ETS (Environmental tobacco smoking) is one of the most common preventable hazards to a child's health. Several studies have investigated the effect of ETS exposure as a risk factor for childhood pneumonia, especially in developing coun-

tries. Effective pneumonia control will be achieved by paying attention to four areas, namely environment, nutrition, case management and vaccines (Suzuki et al., 2009). Children are more susceptible to air pollutants than adults because their immune systems are not yet well developed. Respiratory tract infections are a major cause of mortality and morbidity in children. Infections are traditionally divided into upper respiratory tract infections (such as the common cold) and lower respiratory tract infections (such as pneumonia). Perceived indoor tobacco odor has a greater association than parental smoking with respiratory disease. Children exposed to indoor tobacco odors either during infancy or childhood have a risk of respiratory problems (Zhuge et al. 2020)

Pneumonia-causing pathogens can reach the lungs via different routes. Although information on the pathogenesis of pneumonia is limited, it is widely believed that the bacteria that cause pneumonia are often present in the nose or throat and then be inhaled into the lungs causing infection. Globally, the reported association between childhood ETS exposure and utilization of all-cause media services has been consistently found in certain disease conditions such as asthma exacerbations and respiratory tract infections. The impact of maternal smoking was not specifically investigated in this previous study, even though maternal smoking has a significant impact on children's health compared to smoking other household members (Dai et al. 2020).

Pneumonia is an infectious disease that attacks the lung parenchyma the main cause of under-five mortality in the world, especially developing countries and poor countries. Toddlers are an age group that is vulnerable to nutritional problems and diseases, resulting in disrupted growth and development and can even cause death (lestari et al. 2017). Pneumonia can be caused by different bacterial, viral or fungal agents but only one-third of children with bacterial pneumonia have access to life-saving antibiotics (El-Kofy et al. 2022). Pneumonia is a severe form of acute lower respiratory tract infection which is responsible for high morbidity and mortality among children under five which poses a major threat to public health worldwide (Keleb et al. 2020).

The pattern of food consumption serves to direct the national pattern of food utilization to comply with the standards of quality, variety, nutritional content, safety and halal, in addition to food efficiency and waste prevention. Food consumption patterns also direct the utilization of food in the body (food utility) to be optimal, by increasing awareness of the importance of diverse consumption patterns with balanced nutrition including energy, protein, vitamins and minerals and safe (Picauly et al., 2022).

Malnourishment in children under five has a very detrimental impact, namely decreasing the body's resistance so that it is susceptible to infectious diseases, endurance, decreased IQ, low cognitive competence and even leads to death (Aziza, et al. 2021). The purpose of this study was to analyze and estimate the effect of exposure to tobacco smoke and nutritional status of toddlers on the risk of pneumonia.

SUBJECTS AND METHOD

1. Study Design

This study uses a systematic review method and meta-analysis using primary data, namely data from previous research results. Article search using 3 online databases, namely: Google Scholar, PubMed and Science Direct. The keywords used were “Pneumonia” AND “Exposure to tobacco

smoke" AND "Poor nutritional status" AND "Children under five years" AND "Multivariate" AND "Cross sectional". In addition to using the data base, the author searches for articles by hand searching, namely the bibliography that has been filtered according to the field. There were 14 primary studies that met the inclusion criteria of this study.

2. Steps of Meta-Analysis

1) Formulate research questions in PICO (Population, Intervention, Comparison, Outcome). The research population is toddlers. The research intervention was exposure to tobacco smoke and poor nutritional status. The study comparison was not exposed to tobacco smoke and lack of nutritional status. The research outcome is pneumonia.
2) Search for primary study research articles from 3 online databases namely Google Scholar, PubMed and Science direct.
3) Conduct screening and quality assessment of primary articles.
4) Extracting and analyzing data into the RevMan 5.3 application
5) Interpret the results and conclusions.

3. Inclusion Criteria

The inclusion criteria in this study were full text paper primary research articles using a cross-sectional study design. The analysis used was multivariate with Adjusted Odds Ratio (aOR). Publication of articles in English. combined research models and form the final results of the meta-analysis. The results of data analysis are presented in the form of forest plots and funnel plots.

4. Exclusion Criteria

Articles published in languages other than English, secondary research articles.

5. Operational Definition of Variables

Pneumonia, is an infectious disease characterized by inflammation of one or both lungs which can be caused by viruses, fungi and bacteria, which reduces the ability of the air sacs to absorb oxygen.

Exposure to tobacco smoke is one of the most common preventable hazards to children's health. Several studies have investigated the effect of ETS exposure as a risk factor for childhood pneumonia, especially in developing countries**.**

Malnutrition refers to deficiencies or excesses in nutrient intake, imbalance of essential nutrients or impaired nutrient utilization.

6. Study Instruments

Quality assessment of the main articles in this study was conducted using a critical assessment checklist for cross-sectional studies published by the Joanna Briggs Institute (JBI).

7. Data Analysis

This research was collected using the PRISMA diagram and analyzed using the Review Manager 5.3 application (RevMan 5.3) by calculating the effect size and heterogeneity (I^2) to determine, conduct screening and assess the quality of primary articles, extract and analyze data into the RevMan 5.3 application, interpret the results and draw conclusions.

RESULTS

The process of searching for primary articles related to the effect of exposure to tobacco smoke and malnutrition status in toddlers on the risk of pneumonia in this meta-analysis study was carried out on 3 online databases and the results obtained were 14 articles which can be seen in Figure 1. The process of searching for primary articles was carried out on 3 online databases and obtained the results of 14 articles. The total articles in the initial search process was 1,020 articles with details of 252 articles from the PubMed database, 524 articles from the Google Scholar database, and 244 articles from the

Science database. Then, 378 articles were deleted and 231 full-text articles were eligible, 15 articles were included in the synthesis meta-analysis.

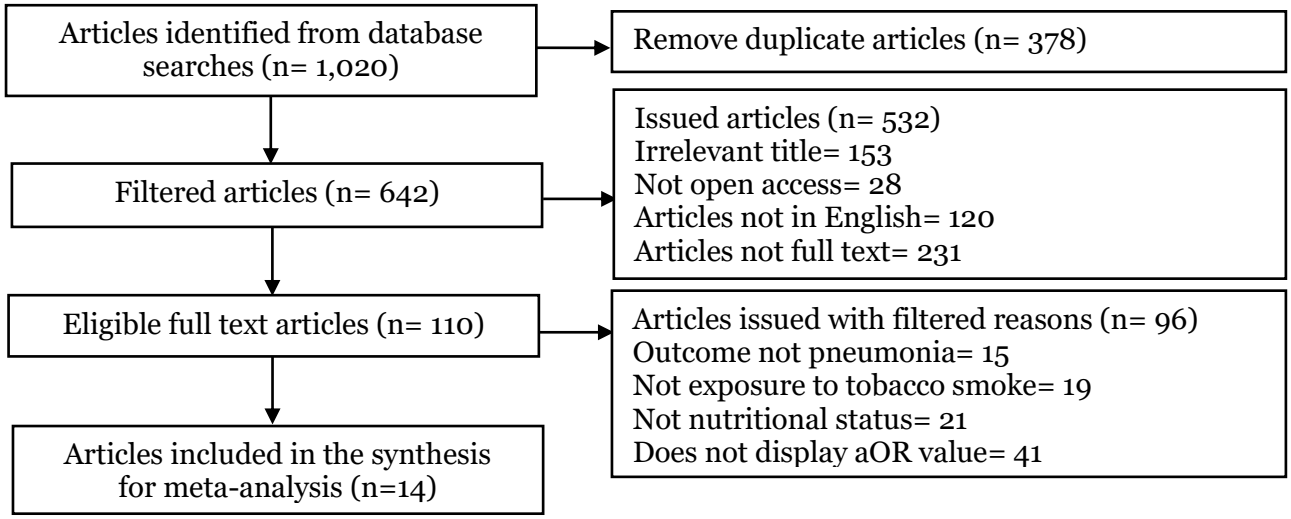

Figure 1. PRISMA flowchart

Figure 2. Map of the distribution of articles included in the meta-analysis

Figure 2 shows an overview of the research areas used in this meta-analysis which are spread across 2 continents, namely Asia and Africa. There were 14 articles at the end of the review process that met quantitative requirements. All articles use cross-sectional studies. Table 1 shows the results of the primary research quality assessment used for this study. The primary study quality assessment in this study was carried out using a cross-sectional appraisal study by JBI (Moola et al., 2017). Based on the results obtained from the study quality assessment, the total scores in the 14 selected primary studies ranged from 15 to 16. This indicates that the quality of all primary articles is worthy.

Table 1. Critical appraisal checklist for cross-sectional studies in meta-analyses

Articles	Questions of Checklist								Total
	1	2	3	4	5	6	7	8	
Dai et al. (2020)	2	2	2	2	2	2	2	2	16
Dharel et al. (2023)	2	2	2	2	2	2	2	2	16
Dagvadorj et al. (2016)	2	2	2	2	2	2	2	2	16
Jroundi et al. (2014)	2	2	2	2	2	2	2	2	16
Kiconco et al.(2021)	2	2	2	2	2	2	2	2	16
Tazinya et al. (2018)	2	2	2	2	2	2	2	2	16
Keleb et al. (2020)	2	2	2	2	2	2	2	2	16
Demis et al. (2022)	2	2	2	2	2	2	1	2	16
Debela et al. (2023)	2	2	2	2	2	2	2	2	16
Hailemariam et al. (2018)	2	2	2	2	2	1	2	2	15
Akinyemi et al. (2018)	2	2	2	2	2	1	2	2	15
Tesfaye (2019)	2	2	2	2	2	1	2	2	15
El-Koofy et al. (2022)	2	2	2	2	2	1	2	2	15
Zhuge et al. (2020)	2	2	2	2	2	1	2	2	15

Description of the question criteria:

1 = Were the criteria for inclusion in the sample clearly defined?
2 = Were the research subjects and settings described in detail?
3 = Is exposure measured in a valid and reliable way?
4 = What are the standard criteria used to measure objective conditions?
5 = Were confounding factors identified?
6 = Was a strategy for dealing with confounding factors stated?
7 = Are the results measured in a valid and reliable way?
8 = Has proper statistical analysis been used?

Description of the answer score:

0 = No
1 = Can't tell
2 = Yes

Table 2 shows that there are 10 research articles on exposure to tobacco smoke in the environment in toddlers on the risk of pneumonia with a cross-sectional meta-analysis study design with a sample size of 52,863. This research was conducted in eight countries including Hong Kong, Nepal, Mongolia, Morocco, Uganda, Cameroon, Ethiopia, China, Nigeria, and Egypt.

Based on Table 3, it shows that of the ten articles that display aOR values related to the effect of exposure to tobacco smoke with the risk of developing pneumonia. The highest aOR value was the highest in the study (Debela, et al. 2023) (aOR = 8.13; 95% CI = 3.93 to 16.8) and the lowest aOR value in the study Tazinya et al. (2018) (aOR= 0.35; 95% CI= 0.222 to 0.011).

Table 2. PICO table summary of cross-sectional articles on primary study sources of exposure to tobacco smoke and malnutrition status

Author (year)	Country	Sampel	P	I	C	O
Dai et al. (2020)	Hongkong	1,541	Toddler	Exposure to tobacco smoke	Not exposed to tobacco smoke	Pneumonia
Dharel et al. (2023)	Nepal	6,658	Toddler	Exposure to household tobacco smoke, Malnutrition status	Not exposed to tobacco smoke, No nutritional	Pneumonia

Author (year)	Country	Sampel	P	I	C	O
Dagvadorj et al. (2016)	Mongolia	1,013	3 year old child	Exposure to tobacco smoke in the household environment	Not exposed to tobacco smoke	Pneumonia
Jroundi et al. (2014)	Morocco	689	Children aged 2-59 months	Exposure to tobacco smoke in the household environment	Not exposed to tobacco smoke	Pneumonia
Kiconco et al. (2021)	Uganda	336	Toddler	Exposure to tobacco smoke in the household environment	Not exposed to tobacco smoke	Pneumonia
Tazinya et al. (2018)	Kamerun	512	Toddler	Exposure to household tobacco smoke and undernutrition status	Not exposed to tobacco smoke and no malnutrition status	Pneumonia
Demis et al. (2022)	Ethiopia	343	Children aged 2-59 months	Exposure to tobacco smoke, and poor nutritional status	Not exposed to tobacco smoke, and no malnutrition status	Pneumonia
Debela et al. (2023)	Ethiopia	465	Toddler	Exposure to tobacco smoke and undernutrition status	Not exposed to tobacco smoke and poor nutritional status	Pneumonia
Hailemariam, et al.(2018)	Ethiopia	130	Toddler	Exposure to tobacco smoke and poor nutritional status	No exposure to tobacco smoke and no malnutrition status	Pneumonia
Zhuge et al.(2020)	China	41,176	3-8 years	Exposure to tobacco smoke	Not exposed to tobacco smoke	Pneumonia
Akinyemi et al. (2018)	Nigeria	59,370	Toddler	Malnutrition status	There is no poor nutriational status	Pneumonia
Tesfaye et al.(2019)	Ethiopia	347	Children aged 2-59 months	Malnutrition status in Ethiopia	There is no poor nutriational status	Pneumonia
El-Koofy et al. (2022)	Mesir	611	Toddler	Malnutrition status in low income countries	There is no poor nutriational status	Pneumonia
Keleb et al. (2020)	Ethiopia	560	Toddler	Malnutrition status in Ethiopia	There is no poor nutriational status	Pneumonia

Table 3. Presents data on adjusted odds ratio (aOR) on the effect of exposure to tobacco smoke on the risk of pneumonia.

Author (Year)	aOR	CI 95%	
		Lower Limit	Upper Limit
Dai et al. (2020)	2.95	0.64	13.51
Dharel et al. (2023)	2.50	1.10	5.70
Dagvadorj et al. (2016)	1.51	1.11	2.07
Jroundi et al. (2014)	1.79	1.18	2.72
Kiconco et al. (2021)	3.00	1.35	6.80
Tazinya et al. (2018)	0.35	0.22	0.01
Demis et al. (2022)	13.7	1.74	21.00
Debela, et al.(2023)	8.13	3.93	16.80
Hailemariam et al.(2018)	5.00	2.10	9.10
Zhuge et al. (2020)	1.05	0.98	1.12

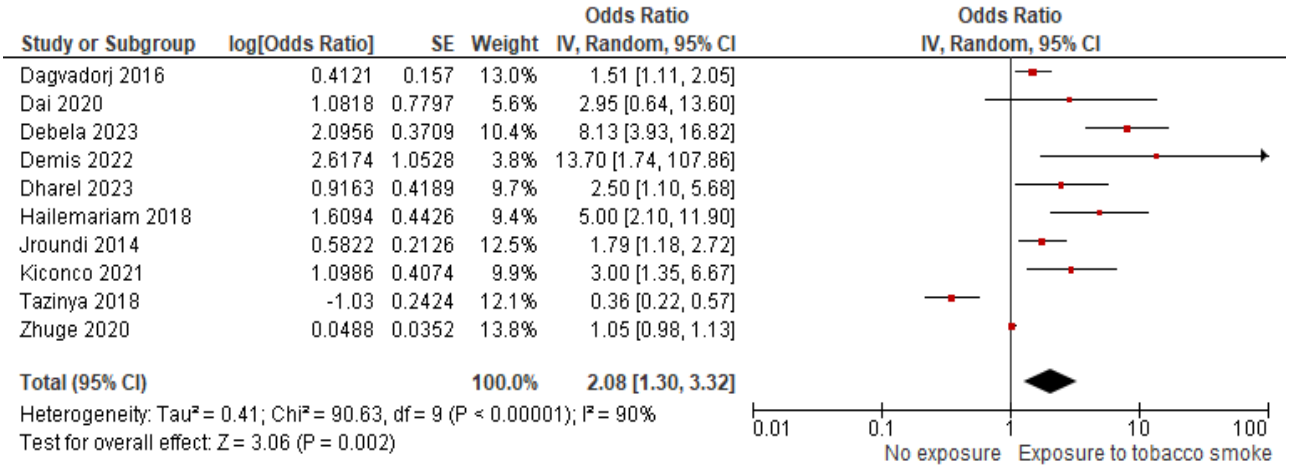

Figure 3. Forest plot of the effect of exposure to tobacco smoke on children under five to the risk of pneumonia

The forest plot in Figure 3 shows that there is an influence between exposure to tobacco smoke and no exposure to tobacco smoke at risk of developing pneumonia in children under five. Children exposed to tobacco smoke were 2.08 times more at risk of developing pneumonia than children under five who were not exposed to tobacco smoke (aOR= 2.08; Cl 95%= 1.30 to 3.32; p= 0.002). The forest plot also shows high heterogeneity of effect estimates between primary studies (I^2= 90%; p < 0.001) thus the calculation of effect estimates is carried out using a random effect model approach.

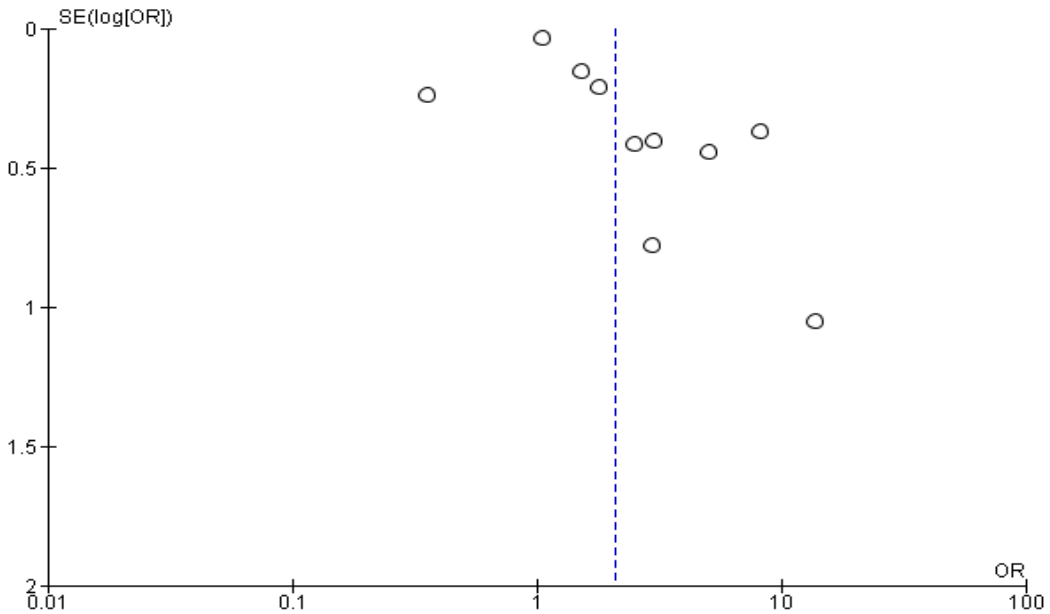

Figure 4. Funnel plot of the effect of exposure to tobacco smoke in toddlers on the risk of pneumonia

The funnel plot in Figure 4 shows an asymmetric distribution of estimated effects on both sides of the vertical, the average effect estimates are located on the right rather than the left. The average for primary studies with a small sample thus the Funnel

plot shows publication bias because the distribution of the estimated effect of the right-hand side of the mean is the same as the location of the diamond shape in the Funnel plot of Figure 4, the publication bias tends to overestimate the true effect.

Table 6 presents the data of adjusted odds ratio (aOR) the effect of undernutrition in toddlers on the risk of pneumonia with a sample size (n= 68.996)

Author (Year)	aOR	CI95%	
		Lower Limit	Upper Limit
Akinyemiet et al. (2018)	1.07	0.93	1.22
Tesfaye et al. (2019)	4.81	1.79	13.00
El-Koofy et al. (2022)	0,76	0.51	1.13
Keleb et al. (2020)	2.43	1.18	5.04
Dharel et al. (2023)	2.3	1.4	3.9
Tazinya et al. (2018)	1.91	0.97	3.76
Demis et al. (2022)	4.2	0.45	8.11
Debela et al. (2023)	3.22	1.66	6.25
Hailemariam et al. (2018)	4.00	1.32	12.14

Table 6 shows that of the nine articles that display aOR values related to the effect of exposure to tobacco smoke with the risk of developing pneumonia. The highest aOR in the study by Tesfaye et al. (2019) (aOR= 4.81; 95% CI= 1.79 to 13.00) and the lowest aOR value was in the study of El-Kofy et al. (2022) (aOR= 2.43; 95% CI= 1.18 to 5.04).

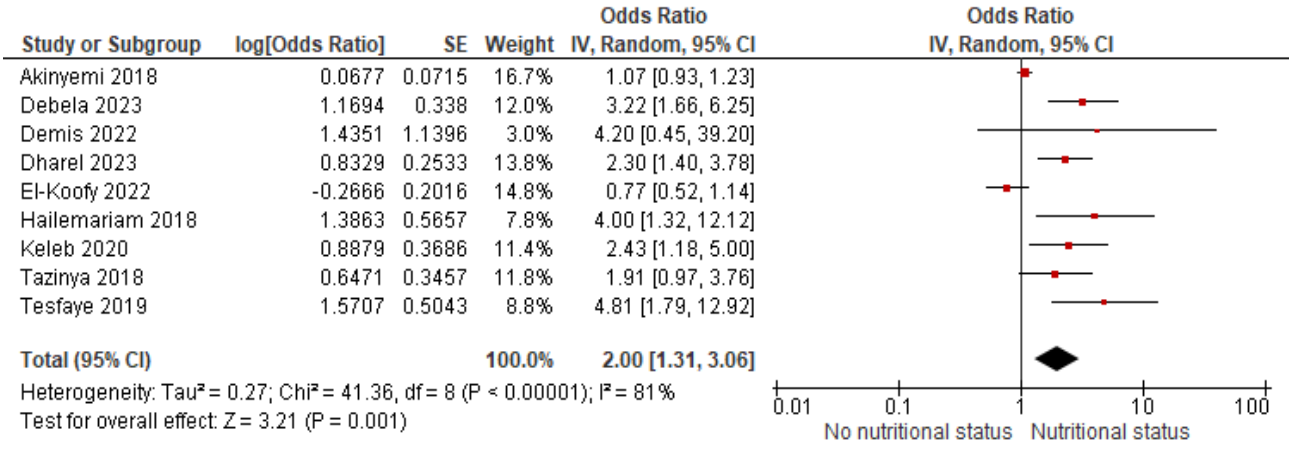

Figure 5. Forest plot of the effect of poor nutritional status in toddlers on the risk of pneumonia

The forest plot in Figure 5 shows that there is an influence between undernutrition status and the absence of undernutrition status in children under five on the risk of pneumonia. Poor nutritional status in children under five has 2.00 times more risk of developing pneumonia compared to children under five who do not have poor nutritional status (aOR=2.00; Cl 95%=1.31 to 3.06; p=0.001). The forest plot also shows high heterogeneity of effect estimates between primary studies (I^2= 81 %; p < 0.001) thus the calculation of effect estimates is carried out using a random effect model approach.

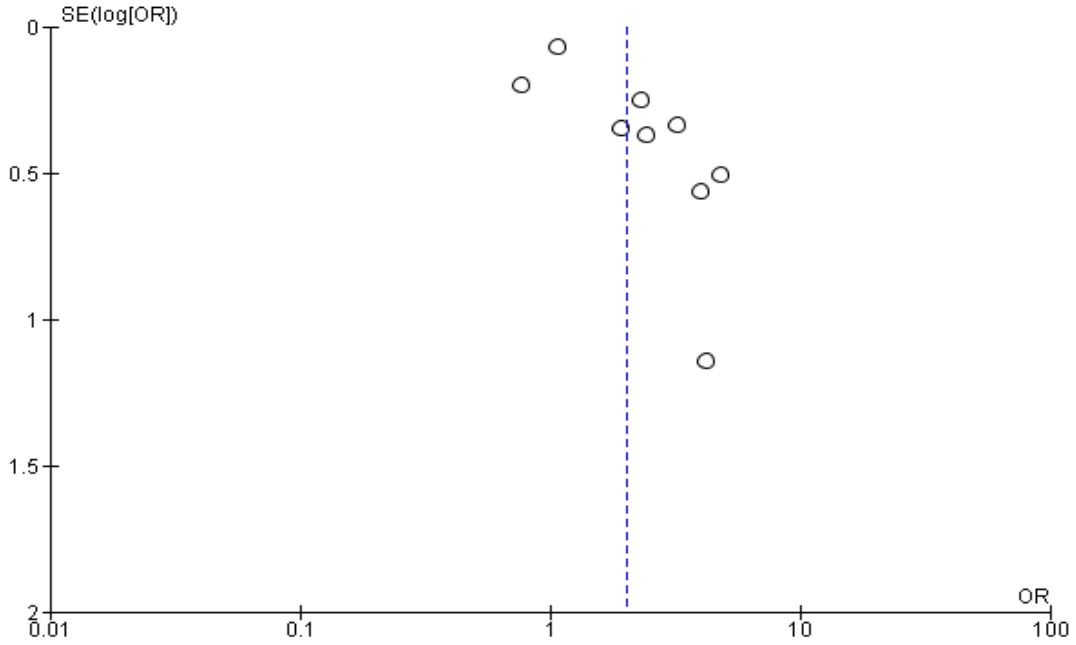

Figure 6. Funnel plot of the effect of undernutrition status on toddlerson the risk of developing pneumonia

The funnel plot in Figure 6 shows that the distribution of effect estimates is asymmetrical on both sides of the vertical, the average effect estimates are more on the right than on the left. The average for the primary study with a small sample, thus the funnel plot shows publication bias because the distribution of the estimated effects of the right line, the average is the same as the location of the diamond shape in the forest plot Figure 6, the publication bias tends to overestimate the actual.

DISCUSSION

This study themed the effect of exposure to tobacco smoke in the environment and malnutrition in toddlers on the risk of pneumonia: a meta-analysis. The intervention in this study was exposure to tobacco smoke and poor nutritional status.

1. The Effect of Exposure to Tobacco Smoke in Toddlers on the Risk of Pneumonia

The relationship between environmental tobacco smoke or referred to as environmental tobacco smoking (ETS) and toddler pneumonia in developed and developing countries has not been proven. A study was conducted to assess the incidence and impact of tobacco smoke exposure (ETS) on pneumonia. ETS exposure is one of the most common preventable hazards to a child's health. Several studies have investigated the effect of ETS exposure as a risk factor for childhood pneumonia, especially in developing countries. Effective pneumonia control will be achieved by paying attention to four areas, namely environment, nutrition, case management and vaccines. (Suzuki et al. 2009).

Tobacco use, especially smoking, has the highest mortality rate in America. Most nicotine-dependent adults started smoking in their teens. Smoking is a behavior that can cause harm to individuals and public health. Cigarettes have three main components, namely nicotine which causes addiction, tar which is carcinogenic and carbon monoxide which has a very strong activity on hemoglobin so that oxygen levels in the

blood decrease and other chemicals that are harmful to the body (Oqui et al. 2022).

Based on the results of a meta-analysis of 10 primary studies with cross-sectional study designs published from various different countries Hong Kong, Vietnam, Nepal, Mongolia, Morocco, Uganda, Cameroon, Ethiopia, Nigeria, Egypt and China, the study subjects were with a total sample size of 52,863 children under five. The results of the meta-analysis showed that exposure to tobacco smoke was 2.08 times more at risk of developing pneumonia than children under five who were not exposed (aOR = 2.08; Cl 95%=1.30 to 3.32; p= 0.002).

2. The Effect of Malnutrition Status in Toddlers on the Risk of Pneumonia

Children will enter the toddler phase which is a phase of rapid growth and development and become one of the groups that are vulnerable to suffering from malnutrition in a community group (Aziza et al. 2021).

Based on the results of a meta-analysis of 9 primary studies with cross-sectional study designs published from various different countries Hong Kong, Vietnam, Nepal, Mongolia, Morocco, Uganda, Cameroon, Ethiopia, Nigeria, Egypt and China, the study subjects with a total sample size of 58,996 children under five. The results of the meta-analysis showed that there was an effect of poor nutritional status 2.00 times more at risk of developing pneumonia compared to children under five who did not have poor nutritional status (aOR=2.00; Cl 95%=1.31 to 3.06; p= 0.001). Toddlers with poor nutritional status have a risk of developing pneumonia. Compared with the absence of poor nutritional status.

Risk factors for pneumonia include malnutrition, indoor air pollution (air polluted by cigarette smoke of family members smoking indoors, use of mosquito coils, and use of wood-burning stoves for cooking in the house, overcrowding of the population living at home, zinc deficiency, mother's educational status and previous experience she may have in raising children, presence of co-morbidities, daycare, humidity, cold, lack of vitamin A in diet, birth order and birth weight (LBW) (Sutriana, et al. 2021).

AUTHOR CONTRIBUTION

Atika Dwi Minawati as the main researcher who chose the topic, conducted a search for data collection in this study. Bhisma Murti and Hanung Prasetya analyzed the data and reviewed research documents.

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CONFLICT OF INTEREST

There is no conflict of interest in this study.

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