



The Effect of Smoking History in Families with the Incidence of Acute Respiratory Infection (ARI) in Toddlers in Indonesia: A Meta-Analysis Study

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ABSTRACT: Acute respiratory tract infection (ARI) is one of the most common causes of death in toddlers in developing countries. It is the cause of a significantly higher death rate in toddlers compared to other infections across all countries in the world. This study aims to analyze the impact of smoking history on the incidence of ARI in toddlers in developing countries in Asia. In December 2024, we conducted a meta-analysis on 59 case-control research articles published in both Indonesian and English between 2014 and 2024. The results of the study showed that there was an influence of smoking history in the family with the incidence of ARI in toddlers in developing countries in Asia (p -value = <0.0001); a history of smoking in the family has a risk of 3.17 times greater, which can result in ARI in toddlers when compared to toddlers who are not exposed to cigarette smoke, and the variation between publications was considered heterogeneous ($=75\%$) with $p = <0.00001$, which was not statistically significant. Periodically carry out education, counseling, and health promotion to enhance family knowledge and awareness, particularly among parents and those closest to toddlers, about not smoking in the house or near toddlers.

KEYWORDS: ARI, Case-control, Developing Asian countries, Families, Toddlers.

INTRODUCTION

Acute respiratory tract infections are sudden infections that affect one or more components of the respiratory system, ranging from the nasal passages to the alveoli, as well as associated structures such as the sinuses, middle ear, and pleura. Acute respiratory infections rank among the primary causes of mortality in toddlers inside developing countries (Hasan & The, 2020). Acute respiratory tract infections are classified as serious infections. Indonesia is a developing nation with a notably high prevalence of Acute Respiratory Infections (ARI) annually. One of the objectives of the third Sustainable Development Goal (SDG) is to guarantee healthy lifestyles and enhance well-being for individuals of all ages (Riskesdas, 2018).

In recent years, deaths caused by ARI in toddlers have reached 526,000, with 1,400 toddlers every day, 60 toddlers every hour, and 1 toddler every 36 seconds. In several years, deaths caused by ARI diseases in toddlers amount to 526,000, 1,400 toddlers each day, 60 toddlers each hour, and 1 toddler every 36 seconds. This will cause the mortality rate among infants to be much higher than from other infections worldwide (Suhada et al., 2020). In this world, countries are divided into two, namely developed and developing countries. The number of deaths caused by respiratory disorders in 2015 was 920,136, with the highest occurrences in South Asia and Africa. According to WHO, the incidence of ARI is quite high in developing countries. In New York, the number of ARI cases was 48,325 in toddlers, and it is estimated that in developing countries, the incidence is 30-70 times higher compared to developed countries. It is suspected that 20% of babies born in developing countries fail to reach the age of five, and 26-30% of toddler deaths are caused by ARI (Togelang et al., 2018). The number of deaths due to lower respiratory tract infections is reported to be highest in Asia, besides the sub-Saharan region of Africa. Indonesia is also one of the countries reporting the incidence of ARI, with as many as 6 million cases (Musfirah & Kamisa, 2023).

The incidence according to the age group of toddlers is estimated at 0.29 episodes per child/year in developing countries and 0.05 episodes per child/year in developed countries. This indicates that there are 156 million new episodes worldwide each year, with 151 million episodes (96.7%) occurring in developing countries. The highest number of cases occurs in India (43 million), China (21 million), and Pakistan (10 million), with Bangladesh, Indonesia, and Nigeria each having 6 million episodes. Of all the cases occurring in the community, 7 – 13% are severe and require hospitalization. Episodes of cough and cold in toddlers in



Indonesia are estimated to occur 2 – 3 times per year. Acute Respiratory Infections (ARIs) are one of the main causes of patient visits to community health centers (40%-60%) and hospitals (15%-30%) (Z.Akbar et al., 2023).

This study uses the results of observational research on the relationship between exposure to cigarette smoke and the incidence of ARI in toddlers in developing countries. This research is expected to better represent diversity when generalized to the population. That generalization is necessary to determine the extent of the intervention's impact, so it can be decided whether it is necessary to focus on whether smoking habits in families affect ARI in children. The generalization of a study to a population cannot be done, so several valid studies are needed to draw a conclusion. The meta-analysis in this study was conducted to assess the strength of the existing evidence regarding ARI diseases occurring in developing countries. This study aims to analyze the impact of smoking history on the incidence of ARI in toddlers in Indonesia.

METHODS

The type of research is a study using the meta-analysis method. Meta-analysis is a research method that summarizes the results of primary studies, followed by the identification, evaluation, and interpretation of all relevant research findings related to a specific research question, topic, or phenomenon of interest, thereby presenting a more comprehensive and balanced view of the facts (Munn Z et al, 2018). Meta-analysis is a statistical method conducted to calculate the weighted average of a parameter (effect size or risk) obtained from relevant studies, where the results of the meta-analysis are presented with a forest plot. Whereas meta-synthesis is a systematic review method that synthesizes the results of qualitative research, resulting in new theories or a deeper and more comprehensive understanding. The software that can be used are EPOC and EviAtlas (Higgins J, Thomas J., 2019).

RESULTS

This research will employ the meta-analysis approach, following the outlined procedures in the research methodology section to derive results and evaluate the findings. This meta-analysis examines the synthesis of multiple pertinent primary research concerning the correlation between cigarette smoke exposure and the occurrence of acute respiratory infections in children under five years old in developing Asian nations. Primary studies were executed by querying electronic databases with diverse keywords pertaining to tobacco smoke exposure in early childhood and the incidence of acute respiratory illnesses. Following the literature search aligned with the inclusion criteria and research selection method, 59 primary studies were found for inclusion in the data analysis phase, and the interpretation of the analysis results was performed.

1. Results of Literature Search and Primary Study Selection

A literature search was performed utilizing an electronic database with various keywords. The literature search commenced with the identification phase, wherein titles relevant to the primary study were selected utilizing keywords such as: "the influence of cigarette smoke and ARI in toddlers in developing countries in Asia" or "the effect of cigarette smoke exposure on toddlers in developing countries in Asia" across multiple electronic databases. During the search procedure, 1,397 titles of pertinent primary studies were identified based on the keywords. Of the 1,397 primary studies, 606 are in Indonesian and 785 are in English, all sourced from the Google Scholar database. Furthermore, there are six titles of primary research from the PubMed database in English. From the search results of both databases, 747 primary studies were identified that had similarity in titles and shared authors across both databases. The subsequent stage involves screening, which is the following selection process to be executed in this meta-analysis investigation. At this juncture, multiple primary studies are chosen based on their summaries or abstracts. Within the screening process, there exists a singular primary study in the Google Scholar and Pubmed databases that is not classified as a case-control study.

This indicates that 335 studies were removed, resulting in the inclusion of only 314 primary studies in the subsequent eligibility stage. Primary studies that successfully complete the screening phase will proceed to the eligibility phase for selection. At this juncture, 314 primary studies will be chosen according to the inclusion criteria set forth by the researchers. The feasibility stage selection identified 59 primary studies from the Google Scholar and Pubmed databases, comprising 51 studies in Indonesian and 8 studies in English, that fulfilled the inclusion criteria concerning cigarette smoke exposure and the incidence of ARI in toddlers. According to these parameters, 255 primary studies failed to meet the inclusion criteria and were eliminated from the analysis, leading to the inclusion of 59 primary studies in this meta-analysis. The specifics of the 58 primary studies are as follows: Fifty-nine primary papers sourced from the Google Scholar database, comprising fifty-two research in Indonesian and seven studies

in English. The illustration of the literature search methodology and the selection of primary studies in this research is depicted in figure 6 below.

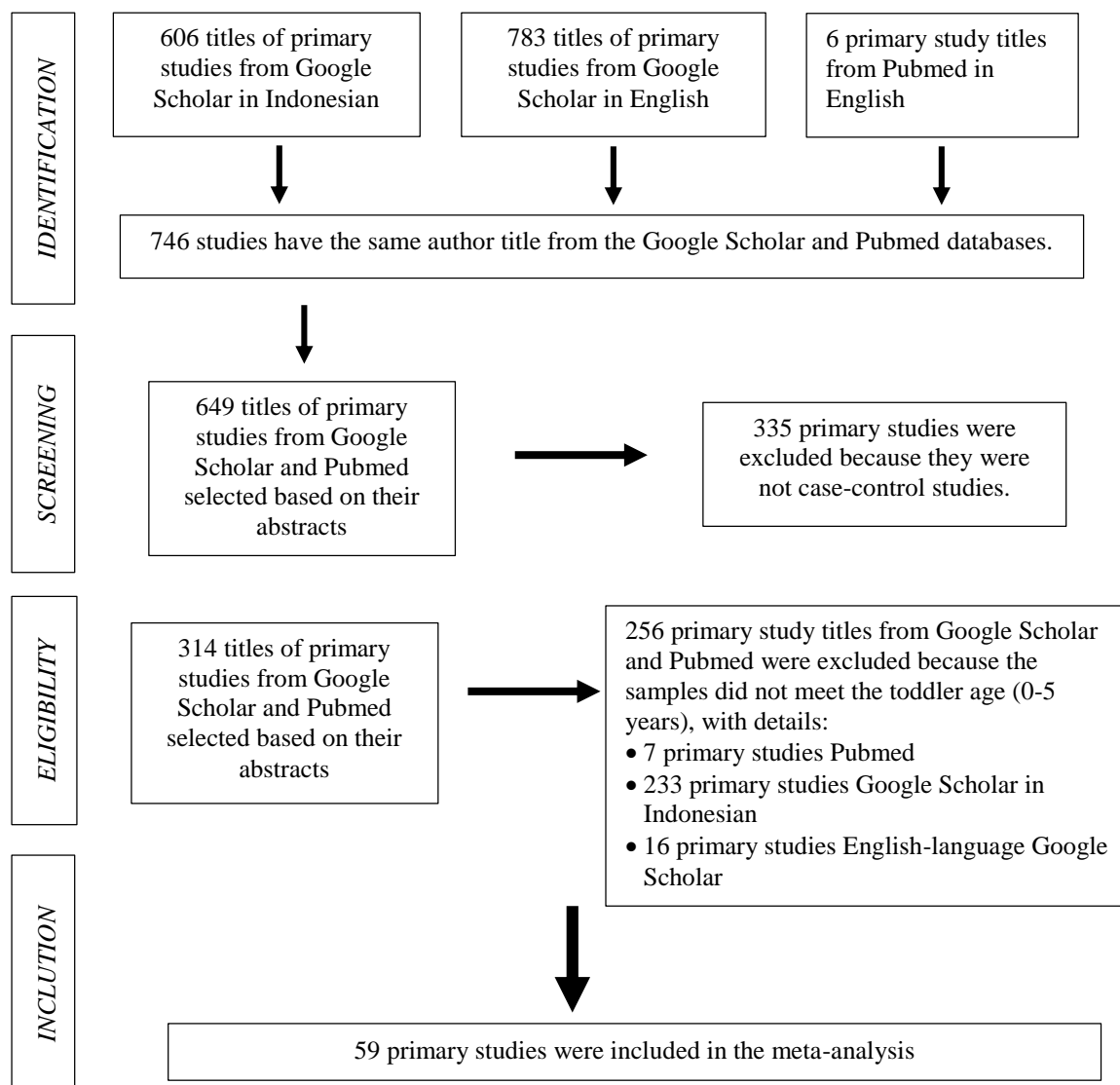


Figure 1. Flowchart of Primary Study Selection

Subsequently, all primary studies (Figure 1) were input into Review Manager 5.4 software for analysis. The Random Effect Model was employed for data analysis, yielding Odds Ratios to assess the connection between cigarette smoke exposure and the incidence of ARI in toddlers. The researchers conducted a publication bias test with a Funnel Plot, taking into account the standard error (SE) value.

2. Exposure to Cigarette Smoke

Fifty-nine selected study publications were acquired, demonstrating exposure to cigarette smoke, including the following:

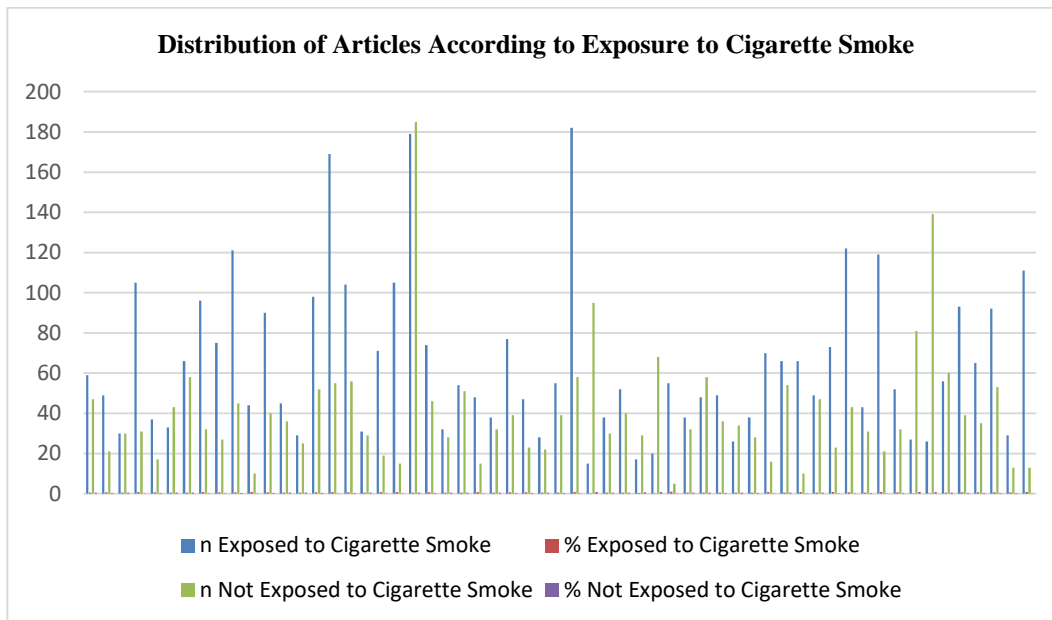


Figure 2. Distribution of Cigarette Smoke Exposure

Figure 2 shows the percentage of cigarette smoke exposure based on the research article, which indicates that on average, 60.19% had exposure to cigarette smoke and 38.91% did not have exposure to cigarette smoke. shows the percentage of cigarette smoke exposure based on the research article taken, where the average is 60.19% exposure to cigarette smoke and 38.91% no exposure to cigarette smoke.

3. The Incidence of ARI in Toddlers

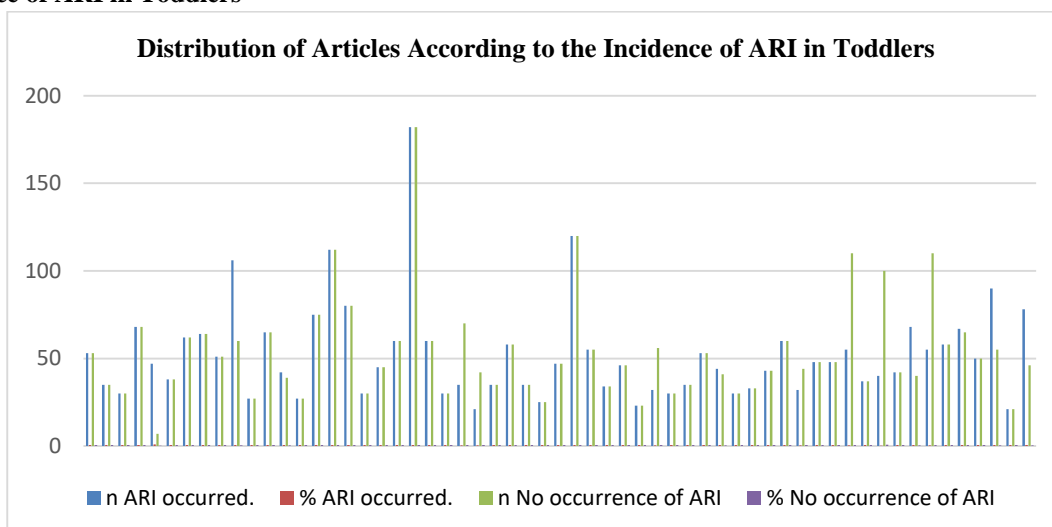


Figure 3. The Incidence of ARI in Toddlers

Figure 3 shows the percentage of ARI incidents in toddlers based on the research article, which indicates that an average of 49.72% of toddlers experienced ARI and 50.28% did not experience ARI.



4. The Effect of Cigarette Smoke Exposure on the Incidence of ARI in Toddlers

a. Forrest Plot

A forest plot is a visual tool often used in meta-analyses to show the results of various different studies in one image. This plot provides a clear picture of the effect size and uncertainty (confidence interval) for each study, as well as the overall results of the meta-analysis. There are 59 research articles in this study used for the meta-analysis, which are case-control studies, and the results obtained are as follows:

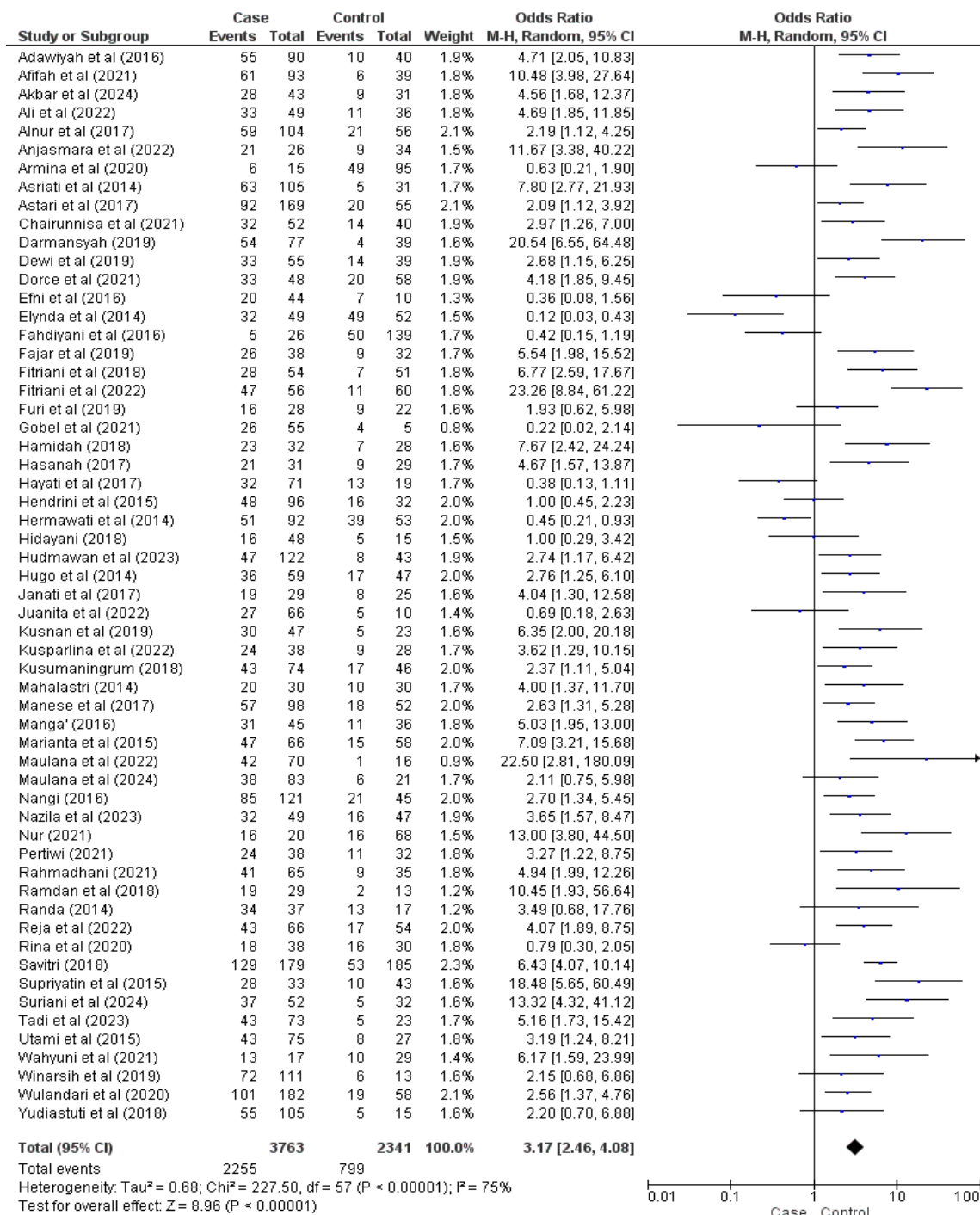


Figure 4. Forrest Plot



Figure 4 further explains the forest plot, such as the position of the diamond, the blue squares for each study relative to the horizontal line (CI). Most of the blue squares in this study (48 studies) are located on the right side of the vertical line, indicating that the further to the right, the greater the influence of the positive relationship, thus the study factors have a large and significant effect. This can be seen in the study codes A12, A55, A49, A40, A17, A41, A4, A16, A34, A27, A30, A39, A24, A54, A29, A23, A18, A48, A1, A14, A28, A42, A22, A3, A15, A13, A7, A43, A50, A10, A46, A36, A38, A56, A58, A5, A44, A21, A6, A51, A47, A9, A35, A31, A20, A59. In addition, there are 11 studies that have blue squares located on the left side. This indicates that the further to the left, the stronger the protective relationship, resulting in non-significant outcomes. Some of these studies can be seen in study codes A32, A11, A2, A53, A37, A19, A8, A57, A25, A45, A33.

Diamond (pooled odds ratio) in this study is located on the right side of the heterogeneity line (CI) with a value of 3.17 (95% CI 2.46 – 4.08). It can be concluded that there is a significant relationship between exposure to cigarette smoke and the incidence of ARI in toddlers. This can be seen with a p -value = < 0.001 (< 0.05). Variation in this study can be seen at p = < 0.001 (< 0.05) and an I^2 value of 75% ($> 50\%$), which means the data is heterogeneous, thus this study uses a random effects model.

The value of heterogeneity is indicated by the I value. The I value was recently developed and introduced as a more preferred and reliable test for I heterogeneity. Ranging from 0 to 100%. Heterogeneity measures the variability between studies, which provides an indication of the comparison of study values in the meta-analysis. In addition, the heterogeneity value is also indicated by the confidence interval (CI) value. Heterogeneity also assesses the variation between and within studies or the comparison of studies from the meta-analysis model. In general, one can choose between two meta-analysis models, namely fixed effect and random effect. If I $< 50\%$, it is considered homogeneous and uses a fixed effect. If I $> 50\%$, then the heterogeneity is very high, and we must use the random effects model for meta-analysis (Retnawati et al., 2018).

b. Funnel Plot

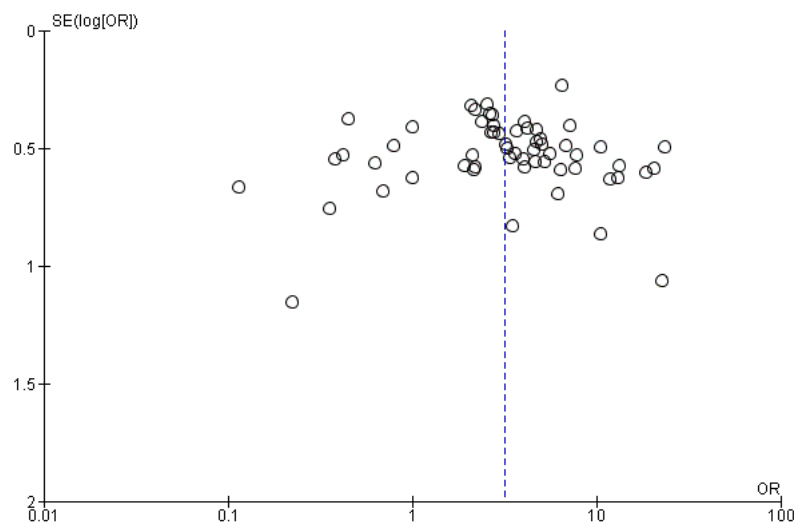


Figure 5. Funnel Plot

Funnel plot is a diagram in meta-analysis that shows the possibility of publication bias. Funnel plot shows the relationship between effect size and sample size or standard error of the effect size from each study examined (Murti, 2018). In the funnel plot (Figure 5), it shows that the distribution is asymmetric, meaning it is unbalanced between the left and right. This means that the research has publication bias. Publication bias is the tendency of editors and researchers to publish articles that yield positive findings, especially when it involves "new" or "spectacular" discoveries, compared to reporting insignificant results. Publication bias is the most significant source of bias in meta-analysis (Murti, 2018).



c. Sensitivity Test

Sensitivity analysis is used to assess whether a meta-analysis result is 'robust' (relatively stable against changes). The test was conducted in this study by comparing the results when analyzed using the fixed effect model with the results analyzed using the random effect model. The fixed effect model is used when the data variance is homogeneous ($p\text{-value} > \alpha$), while the random effect model is used when the data variance is heterogeneous ($p\text{-value} < \alpha$), as follows:

Table 1. Sensitivity Test

Variable	n	Fixed Effect Model Odds Ratio 95% CI	Heterogeneity (p value)	Random Effect Model Odds Ratio 95% CI
The Influence of Cigarette Smoke Exposure on the Incidence of ARI in Toddlers in Asia	59	3,11 (95% CI 2,77-3,49) $p = < 0,00001$	$< 0,00001$	3,17 (95% CI 2,46-4,08) $p = < 0,00001$

The comparison in Table 1 shows that for the variable of the effect of cigarette smoke exposure on the incidence of ARI in toddlers, there is a difference in the pooled odds ratio in the fixed effect model of 3.11 (95% CI 2.77-3.49), whereas in the random effect model it is 3.17 (95% CI 2.48-4.07) with a heterogeneity value of < 0.00001 . It can be concluded that both models have the same p-value, which is $< 0.00001 (< 0.05)$. This means that the variation in this study is not statistically significant.

DISCUSSION

The Effect of Family Smoking History on the Incidence of ARI in Toddlers in Indonesia

In Figure 4, there are 58 research articles that obtained a $p\text{-value} = < 0.001$. This means there is a significant relationship between a family history of smoking and the incidence of ARI in toddlers in developing Asian countries. The more frequently toddlers are exposed to cigarette smoke every day, the higher the risk of developing ARI. This is caused by cigarette smoke that disrupts the respiratory defense system (Riyanto & Kusumawati, 2016). At the toddler age, there is a tendency to have a higher likelihood of contracting ARI compared to older children, due to their lower immune system (Warjiman et al., 2017). Additionally, the lack of parental knowledge regarding the dangers of cigarette smoke that can lead to ARI incidents in toddlers, whereas the aspect of parental knowledge has a significant influence with a p-value of 0.04 (Armiyati, 2021).

The research conducted by Arum Astrini (2014) titled "The Relationship Between Cigarette Smoke Exposure and the Incidence of ARI in Patukan Ambarketawang Gamping Sleman Yogyakarta." Based on the results obtained, there is a relationship between exposure to cigarette smoke and the incidence of ARI in Dusun Patukan Ambarketawang Gamping Yogyakarta with $p=0.000 (p<0.05)$. Another study by Riyanto and Kusumawati (2016) titled "The Influence of Cigarette Smoke on the Frequency of ARI in Toddlers at Kedung Banteng Bayumas Health Center." Based on several studies, it can be concluded that the smoking behavior or habits of parents and close relatives within the family environment can lead to the occurrence of ARI in toddlers. This can be caused by the exposure to cigarette smoke that frequently affects toddlers every day, the lower immune system of toddlers which disrupts the respiratory defense system, and the parents' lack of knowledge about the dangers posed by cigarette smoke, which can lead to the occurrence of ARI in toddlers.

The Combined Effect of Research on the Influence of Family Smoking History on the Incidence of ARI in Toddlers in Indonesia

Figure 4 presents the aggregated effect estimate from 58 research articles, resulting in a pooled odds ratio of 3.17 (95% CI 2.46 – 4.08), indicating that a family history of smoking significantly increases the risk of acute respiratory infections in toddlers by 3.17 times compared to those not exposed to cigarette smoke. Cigarette smoke can impair the respiratory system in children; thus, increased exposure correlates with a heightened chance of getting acute respiratory infections (Seda, Trihandini, & Permana, 2021). Multiple studies indicate that indoor cigarette smoke exposure significantly increases the risk of pneumonia-related ARI in children compared to outside smoking (Ardia et al., 2019).



Cigarette smoke can elevate the incidence of acute respiratory infections in children by 4.2 times relative to those not exposed to cigarette smoke (Lailiyah, 2021). Toddlers exposed to tobacco smoke have a 4.5-fold increased risk relative to those not exposed (Akbar et al., 2024). Numerous studies indicate that exposure to cigarette smoke in toddlers elevates the incidence of ARI in this age group. Moreover, exposure to cigarette smoke in toddlers can impair lung defense mechanisms and promote the onset of respiratory illnesses in this age group. Smoking indoors elevates the prevalence of respiratory illnesses in toddlers relative to smoking outside. Moreover, the community's permissive stance, despite its awareness of the hazards associated with tobacco smoke exposure, may result in respiratory illnesses in children.

The Influence of Variation among Publications Related to the Impact of Smoking History in Families on the Incidence of ARI in Toddlers in Indonesia

The variability among publications concerning the effect of family smoking history on the occurrence of ARI in toddlers in developing Asian nations is illustrated in Table 1, which presents a heterogeneous value ($I^2 = 75\%$) with a p-value < 0.001 in both the fixed and random effect models, signifying the existence of variation. Concerning smoking behavior and its association with pneumonia incidence in toddlers, there exists heterogeneity ($p = < 0.01$) in both the fixed effect model and the random effect model (Anjaswanti et al., 2022). A 95% confidence interval that does not include the number 1 indicates no difference between the two models, rendering the result statistically unimportant.

CONCLUSION

1. Family smoking history significantly influences the frequency of acute respiratory infections in toddlers in underdeveloped Asian nations (p value $= < 0.0001$).
2. The magnitude of the combined effect from research on the influence of family smoking history on the incidence of ARI in toddlers in developing Asian countries indicates that a family smoking history poses a risk 3.17 times greater for ARI incidents in toddlers compared to those not exposed to cigarette smoke.
3. The discrepancy among papers concerning the impact of family smoking history on the prevalence of ARI in toddlers in developing Asian nations is diverse ($I^2 = 75\%$) with $p = < 0.00001$, but not statistically significant.

REFERENCES

1. Hasan, M. & The, F., 2020. Analisis Deskriptif ISPA pada Anak dan Balita di Pulau Moti. *Techno: Jurnal Penelitian*, 9(1), pp. 382. Available at: <https://doi.org/10.33387/tjp.v9i1.1654>.
2. Riskesdas, 2018. Hasil Utama Riskesdas 2018. *Jurnal of Food and Nutrition Research*, 2(12), pp. 1029–1036. Available at: <https://doi.org/10.12691/jfnr-2-12-26>.
3. Suhada, S.B.N., Novianus, C. & Wilti, I.R., 2020. Faktor-Faktor yang Berhubungan dengan Kejadian ISPA pada Balita. *Cendekia Medika*, 5(1), pp. 1–15. Available at: <https://doi.org/10.52235/cendekiamedika.v5i1.8>.
4. Musfirah, M. & Kamisa, R., 2023. Kejadian ISPA Pada Anak Usia Kurang Dari 12 Tahun Di Wilayah Kerja Puskesmas Sebengkok, Kota Tarakan. *Jurnal Kesehatan Dan Pengelolaan Lingkungan*, 4(2), pp. 58–65.
5. Higgins, J. et al., 2019. Updated guidance for trusted systematic reviews: a new edition of the Cochrane Handbook for Systematic Reviews of Interventions. *Cochrane Library*, 3(10). Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10284251/>.
6. Munn, Z. et al., 2018. Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. *Medical Research Methodology*. Article number: 143. Available at: <https://bmcmmedresmethodol.biomedcentral.com/articles/10.1186/s12874-018-0611-x>.
7. Seda, S., Trihandini, T. & Permana, P., 2021. Hubungan Perilaku Merokok Orang Terdekat Dengan Kejadian ISPA Pada Balita Yang Berobat Di Puskesmas Cempaka Banjarmasin. *Jurnal Keperawatan Suaka Insan*, 6(2). Available at: <https://journal.stikessuakainsan.ac.id/index.php/jksi/article/view/293>.
8. Riyanto, R. & Kusumawati, A., 2016. Pengaruh Asap Rokok Terhadap Frekuensi Terjadinya Penyakit ISPA Pada Balita Di Puskesmas Kedung Banteng Banyumas. *Jurnal Ilmiah Ilmu-Ilmu Kesehatan*, 14(3). Available at: <https://jurnalnasional.ump.ac.id/index.php/medisains/article/view/1614>.
9. Anjaswanti, R.N. et al., 2022. Studi Meta-Analisis: Faktor Risiko Kejadian Pneumonia Pada Balita Di Indonesia Tahun



2016-2021. Journal of Community Mental Health and Public Policy, 4(2). Available at: <https://doi.org/10.51602/cmhp.v4i2.65>.

10. Armiyati, T., 2021. Hubungan Perilaku Merokok Orang Tua Dengan Kejadian Infeksi Saluran Pernafasan Akut (ISPA) Pada Balita Di Wilayah Kerja Puskesmas Bestari Medan Petisah. Available at: <http://repository.uinsu.ac.id/13300/1/TASYA%20ARMIYATI.pdf>.
11. Murti, B., 2018. Teori Promosi dan Perilaku Kesehatan. Surakarta: Master Program of Public Health.
12. Togelang, M.R., Warouw, F. & Joseph, W.B., 2018. Hubungan Antara Kondisi Fisik Rumah dengan Kejadian ISPA Pada Balita di Desa Kalinaun Kabupaten Minahasa Utara. Kesmas: Jurnal Kesehatan Masyarakat Universitas Sam Ratulangi, 7(3), pp. 1–7. Sebengkok, Kota Tarakan', Jurnal Kesehatan Dan Pengelolaan Lingkungan, 4(2), pp. 58–65.

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