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Review

RISK FACTORS FOR PEDICULOSIS CAPITIS INFESTATION IN INDONESIA: A META-ANALYSIS

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ABSTRACT

Risk Factors for Pediculosis Capitis Infestation in Indonesia: A Meta-Analysis. *Pediculosis capitis is an infection of the scalp or hair caused by infestation with the ectoparasitic species Pediculus humanus capitis (head lice). Pediculosis in humans remains a public health problem affecting millions of people worldwide; therefore, head lice and body lice constitute distinct concerns with different genotypes and ecotypes. The prevalence of head lice infestation is significantly associated with numerous risk factors, including sociodemographic characteristics, personal hygiene practices, socioeconomic status, educational level, behavioral and environmental factors, in addition to host-related factors. This study aimed to analyze the risk factors of hair length, personal hygiene, and sex in relation to Pediculosis capitis infestation. This study employed a meta-analysis, a statistical method that quantitatively synthesizes results from multiple studies by estimating pooled effect sizes, using JASP software version 0.16.4.0. Data sources included Google Scholar, ResearchGate, and PubMed. Following screening based on predefined inclusion and exclusion criteria, 29 eligible research articles were included. Secondary data from the meta-analysis indicated that hair length (pooled OR = 2.225; 95% CI: 0.61–0.99), personal hygiene (pooled OR = 1.915; 95% CI: 0.44–0.86), and sex (pooled OR = 2.611; 95% CI: 0.68–1.24) were significantly associated with Pediculosis capitis infestation. The meta-analysis concluded that sex represented the highest risk factor for Pediculosis capitis infestation, while personal hygiene showed the lowest risk. Health education, along with personal hygiene promotion and improved environmental sanitation programs, is required to enhance public awareness and attitudes toward the prevention and control of head lice infestation.*

INTRODUCTION

Pediculosis capitis is an infection of the scalp or hair caused by infestation with the ectoparasitic species Pediculus humanus capitis (head lice)[(1)]. The species Pediculus humanus consists of two ecotypes, namely the body louse (P. h. humanus) and the head louse (P. h. capitis). These two ecotypes exhibit nearly identical morphology but differ in their ecology and nutritional patterns[(2)]. Head lice are obligate parasites that spend their entire life cycle on the human host and feed exclusively on blood[(3)]. The diagnosis of head lice

infestation is generally based on the presence of adult lice, eggs (nits) attached to the hair shafts, itching, and inflammation of the scalp[4].

Pediculosis in humans remains a public health problem affecting millions of people worldwide; therefore, head lice and body lice constitute distinct concerns associated with different genotypes and ecotypes[5]. The prevalence of Pediculosis capitis among school-aged children is estimated at 19%, with the highest prevalence reported in Central and South America at 33% and the lowest in Europe at 5%[6]. The prevalence of head lice infestation is significantly associated with multiple risk factors, including sociodemographic characteristics, personal hygiene practices, socioeconomic status, educational level, behavioral factors, and environmental conditions, in addition to host-related factors[7,8]. A study among elementary school children in Al-Mukalla City, Yemen, demonstrated a high prevalence of head lice infestation that was significantly associated with socioeconomic status, personal hygiene, and a history of head lice infestation in at least one family member[9].

This study employed a literature review to synthesize existing data and provide updated information on the risk factors of Pediculosis capitis. Accordingly, a systematic review was conducted by integrating available studies to offer an overall perspective on the prevalence and risk factors of Pediculosis capitis in Indonesia for researchers and public health policymakers. This study aimed to perform a meta-analysis of the prevalence and risk factors of Pediculosis capitis in Indonesia to address the limitations of previous fragmented studies that reported heterogeneous findings. To date, no pooled national prevalence estimate or comprehensive synthesis of risk factors has been available, hindering the formulation of robust and context-specific conclusions. Through this meta-analysis, a more accurate and representative overview is expected to strengthen the scientific evidence base and support public health intervention planning in Indonesia.

MATERIALS AND RESEARCH METHODS

Study Quality Assessment

The risk of bias of the included studies was assessed in accordance with the PRISMA 2020 guidelines using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Analytical Cross-Sectional Studies. The assessment was conducted independently by two reviewers, and any discrepancies were resolved through discussion. The results of the quality assessment were considered in the interpretation of findings and in the sensitivity analysis of the meta-analysis.

Literature Search Strategy

The literature search was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The authors evaluated the prevalence of *Pediculosis capitis* in Indonesia using secondary data obtained from studies available in electronic databases, including MEDLINE (via PubMed), Google Scholar, and ResearchGate. Articles published between 2016 and 2022 were included. The search keywords used were "*Pediculosis capitis*", "*Pediculus humanus capitis*", "*Pediculus capitis*", "head lice infestation", "risk factors of *Pediculosis capitis*", "personal hygiene", "hair length", and "sex".

Study Selection

The inclusion criteria comprised cross-sectional studies reporting the prevalence of *Pediculosis capitis* and its associated risk factors. The exclusion criteria included articles that reported only final results without complete data, studies without a clearly defined sample size, case–control studies, and clinical trials that did not report prevalence estimates.

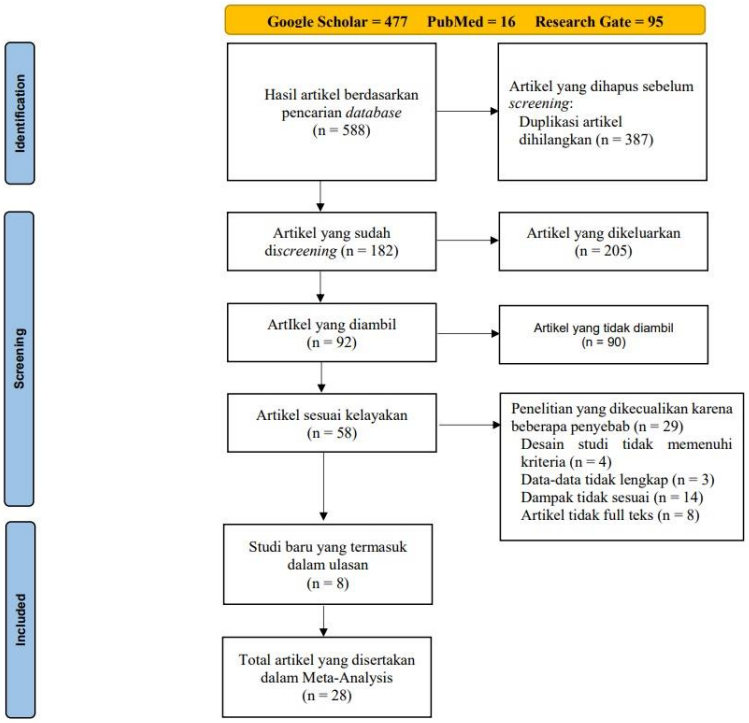

Figure 1. PRISMA Flow Diagram (PRISMA 2020 Statement) for Risk Factors of Hair Length, Personal Hygiene, and Sex Associated with *Pediculosis capitis* Infestation.

Data Extraction

Extracted study characteristics included author name, year of publication, study design, study period, sample size, and prevalence of *Pediculosis capitis* infestation according to hair length, personal hygiene, and sex. Corresponding p-values indicating associations between potential risk factors and *Pediculosis capitis* infestation were recorded and compiled in a Microsoft Excel worksheet.

Meta-Analysis

Data were compiled and analyzed using JASP software version 0.16.4.0 with a significance level of 5% ($\alpha = 0.05$). If between-study variability was homogeneous or the heterogeneity p-value exceeded 0.05, a fixed-effect model was applied. Conversely, when heterogeneity was present or the heterogeneity p-value was less than 0.05, a Restricted Maximum Likelihood (REML) model was used. The meta-analysis calculated the Prevalence Ratio (PR) based on the following criteria:

A PR estimate > 1 with a confidence interval not crossing 1 indicated a risk factor for *Pediculosis capitis* infestation.
A PR estimate < 1 with a confidence interval not crossing 1 indicated a protective factor.
A PR estimate equal to 1 indicated no association with *Pediculosis capitis* infestation.

The pooled effect sizes were presented using forest plots for each analyzed variable. Funnel plot asymmetry was assessed using Egger's test to identify potential publication bias. Sensitivity analysis was performed by comparing results obtained from the fixed-effect model and the REML model to evaluate the robustness and stability of the meta-analysis findings.

RESEARCH RESULTS AND DISCUSSION

Hair Length as a Risk Factor for *Pediculosis capitis* Infestation

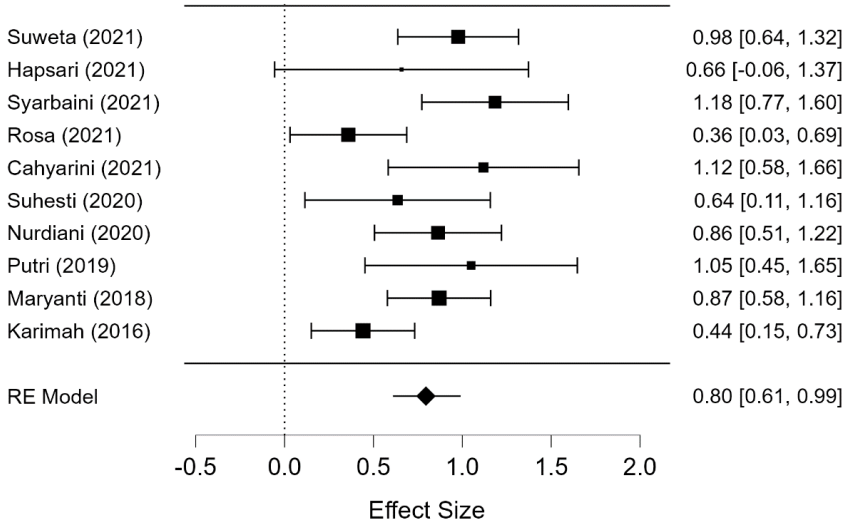

Figure 2. Forest Plot of Hair Length as a Risk Factor for *Pediculosis capitis* Infestation

The effect size value (RE model), representing the estimated Prevalence Ratio (PR), showed a 95% confidence interval centered at 0.80, with a range of 0.61–0.99. The forest plot presented in Figure 2 indicates that the pooled PR value was calculated as $e^{0.80}$ = 2.225. Therefore, it can be concluded that hair length was associated with a 2.225-fold increased risk of *Pediculosis capitis* infestation.

Table 1. Heterogeneity Test for Hair Length as a Risk Factor for *Pediculosis capitis* Infestation

Fixed and Random Effects

	Q	df	p
Omnibus test of Model Coefficients	67.153	1	< .001
Test of Residual Heterogeneity	19.757	9	0.019

Based on Table 1, the p-value obtained from the heterogeneity test was lower than α (0.05), with p = 0.019, indicating that between-study variation was heterogeneous. Therefore, the Restricted Maximum Likelihood (REML) model was applied in this analysis.

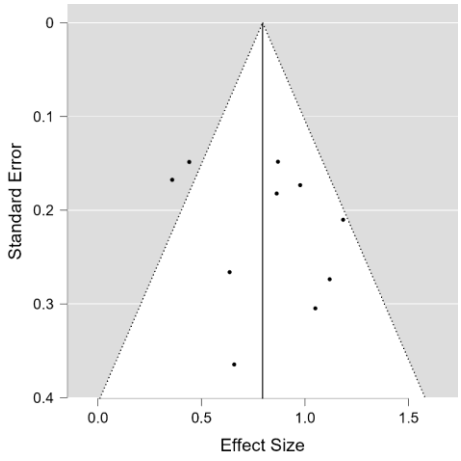

Figure 3. Funnel Plot of Hair Length as a Risk Factor for *Pediculosis capitis* Infestation

Figure 3 presents the funnel plot used to assess potential publication bias by evaluating whether the distribution of the plots formed a symmetrical or asymmetrical pattern. This assessment was followed by Egger's test, a regression-based test applied to asymmetrical funnel plots to further detect the presence of publication bias.

Table 2. Egger's Test for Publication Bias of Hair Length as a Risk Factor for *Pediculosis capitis* Infestation

Regression test for Funnel plot asymmetry ("Egger's test")		
	z	**p**
sei	0.828	0.407

Based on Table 2, the p-value of Egger's test was greater than α (0.05), indicating no evidence of publication bias for the hair length variable in relation to *Pediculosis capitis* infestation. The results of the meta-analysis demonstrated that individuals with long hair had a 2.225-fold higher risk of experiencing *Pediculosis capitis* infestation. These findings are consistent with a study by Kassiri Hamid, which reported that the prevalence of *Pediculosis capitis* infestation was higher among individuals with long hair and that hair length was significantly associated with *Pediculosis capitis* infestation ($p < 0.05$)[7].
This association may be explained by the characteristics of long hair, which tend to provide a warm and humid environment conducive to the survival and reproduction of head lice. In addition, long hair is more difficult to wash thoroughly than short hair, resulting in less optimal hair hygiene practices[10].

Personal Hygiene as a Risk Factor for *Pediculosis capitis* Infestation

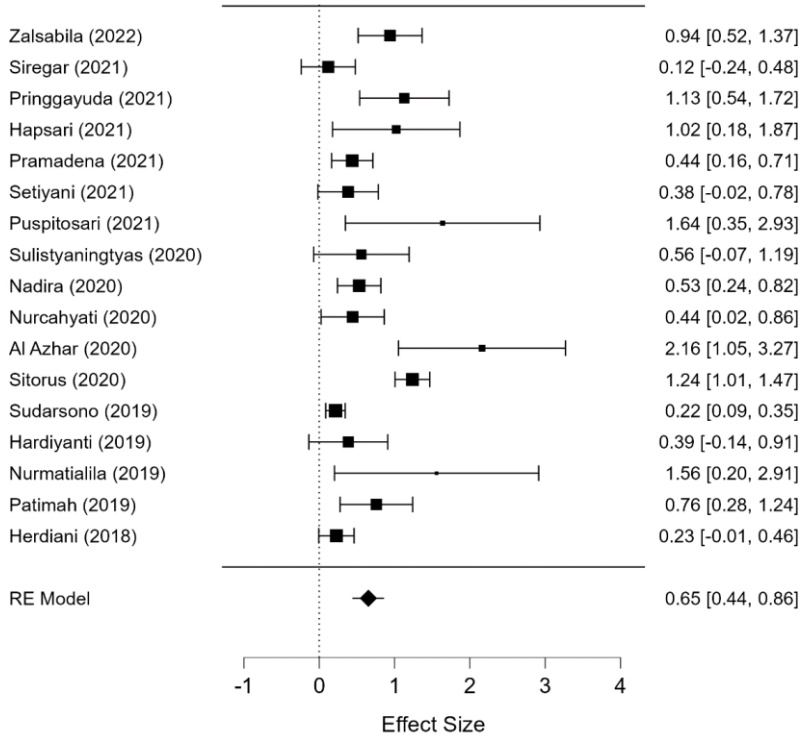

Figure 4. Forest Plot of Personal Hygiene as a Risk Factor for *Pediculosis capitis* Infestation

The effect size value (RE model), representing the estimated Prevalence Ratio (PR), showed a 95% confidence interval centered at 0.65, with a range of 0.44–0.86. The forest plot presented in Figure 4 indicates that the pooled PR value was calculated as $e^{0.65}$ = 1.915. Therefore, it can be concluded that personal hygiene was associated with a 1.915-fold increased risk of *Pediculosis capitis* infestation.

Table 3. Heterogeneity Test for Personal Hygiene as a Risk Factor for *Pediculosis capitis* Infestation

Fixed and Random Effects			
	Q	**df**	**p**
Omnibus test of Model Coefficients	36.356	1	< .001
Test of Residual Heterogeneity	92.436	16	< .001

Based on Table 3, the p-value obtained from the heterogeneity test was lower than α (0.05), with p < 0.001, indicating substantial heterogeneity among studies. Therefore, the Restricted Maximum Likelihood (REML) model was applied in this analysis.

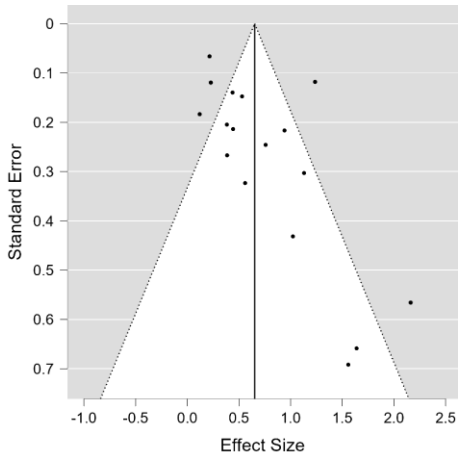

Figure 5. Funnel Plot of Personal Hygiene as a Risk Factor for *Pediculosis capitis* Infestation

Figure 5 presents the funnel plot used to assess the presence of publication bias by examining whether the distribution of effect estimates formed a symmetrical or asymmetrical pattern. This evaluation was subsequently followed by Egger's test, a regression-based method applied to asymmetrical funnel plots to further identify potential publication bias.

Table 4. Egger's Test for Publication Bias of Personal Hygiene as a Risk Factor for *Pediculosis capitis* Infestation

Regression test for Funnel plot asymmetry ("Egger's test")		
	z	**p**
sei	3.040	0.002

Based on Table 4, the p-value of Egger's test was lower than α (0.05), indicating the presence of publication bias for the personal hygiene variable in relation to *Pediculosis capitis* infestation. The results of the meta-analysis showed that poor personal hygiene was associated with a 1.915-fold increased risk of *Pediculosis capitis* infestation. These findings are consistent with a study by Zahirnia *et al.*, which reported that personal hygiene was significantly associated with *Pediculosis capitis* infestation (p < 0.05), and that the level of infestation decreased significantly as personal hygiene practices improved[11]. When factors influencing personal hygiene are adequate, they contribute to better personal hygiene

practices, which in turn can reduce the risk of skin diseases such as *Pediculosis capitis* associated with poor personal hygiene.

Sex as a Risk Factor for *Pediculosis capitis* Infestation

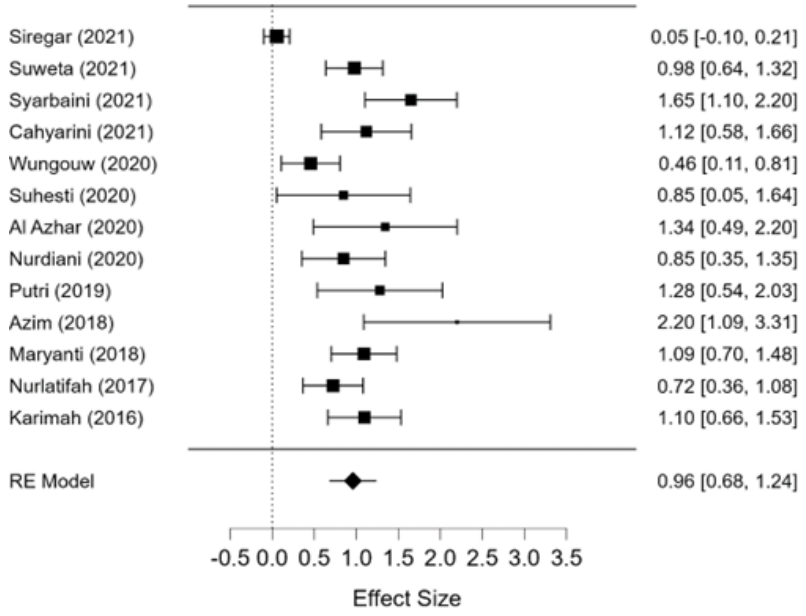

Figure 6. Forest Plot of Sex as a Risk Factor for *Pediculosis capitis* Infestation

The effect size value (RE model), representing the estimated Prevalence Ratio (PR), showed a 95% confidence interval centered at 0.96, with a range of 0.68–1.24. The forest plot presented in Figure 6 indicates that the pooled PR value was calculated as $e^{0.96}$ = 2.611. Therefore, it can be concluded that sex was associated with a 2.611-fold increased risk of *Pediculosis capitis* infestation.

Table 5. Heterogeneity Test for Sex as a Risk Factor for *Pediculosis capitis* Infestation

Fixed and Random Effects

	Q	df	p
Omnibus test of Model Coefficients	46.595	1	< .001
Test of Residual Heterogeneity	98.233	12	< .001

Based on Table 5, the p-value obtained from the heterogeneity test was lower than α (0.05), with p < 0.001, indicating significant heterogeneity among studies. Therefore, the Restricted Maximum Likelihood (REML) model was applied in this analysis.

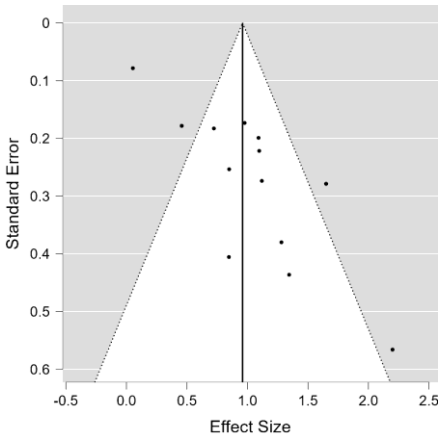

Figure 7. Funnel Plot of Sex as a Risk Factor for *Pediculosis capitis* Infestation

Figure 7 presents the funnel plot used to assess the presence of publication bias by examining whether the distribution of effect estimates formed a symmetrical or asymmetrical pattern. This assessment was subsequently followed by Egger's test, a regression-based method applied to asymmetrical funnel plots to further identify potential publication bias.

Table 6. Egger's Test for Publication Bias of Sex as a Risk Factor for *Pediculosis capitis* Infestation

Regression test for Funnel plot asymmetry ("Egger's test")		
	z	**p**
sei	4.014	< .001

Based on Table 6, the p-value of Egger's test was lower than α (0.05), indicating the presence of publication bias for the sex variable in relation to *Pediculosis capitis* infestation. The results of the meta-analysis demonstrated that females had a 2.611-fold higher risk of *Pediculosis capitis* infestation. These findings are consistent with a study by Djohan *et al.*, which reported that sex was significantly associated with *Pediculosis capitis* infestation, with girls being at higher risk than boys (p = 0.018)[12].

This increased risk may be attributed to the fact that girls generally have longer hair, which can harbor parasites more easily. In addition, behavioral differences related to sex may contribute to this disparity, as girls tend to engage more frequently in activities involving prolonged close physical contact (head-to-head) and are more likely to share personal items such as combs, toothbrushes, and towels[8].

Table 7. Summary of Meta-Analysis Results for Hair Length, Personal Hygiene, and Sex in Relation to *Pediculosis capitis* Infestation

No	**Study Variables**	**N**	***Restricteed ML***	
			PR	**95% CI**
1.	Hair Length	10	2,225	0,61 – 0,99
2.	Personal Hygiene	17	1,915	0,44 – 0,86
3.	Sex	13	**2,611**	**0,68 – 1,24**

Based on the results presented in Table 7, the variable with the highest risk was sex, with a pooled PR value of $e^{0.96}$ = 2.611 (95% CI: 0.68–1.24). Thus, it can be concluded that females had a 2.611-fold higher risk of *Pediculosis capitis* infestation. This was followed by hair length, which was associated with a 2.225-fold increased risk. The lowest risk factor was personal hygiene, with a pooled PR value of $e^{0.65}$ = 1.915 (95% CI: 0.44–0.86), indicating that

individuals with poor personal hygiene had a 1.915-fold higher risk of *Pediculosis capitis* infestation compared with those who maintained good personal hygiene.

Sensitivity Analysis of Risk Factors Associated with *Pediculosis capitis* Infestation
Sensitivity analysis was conducted to identify heterogeneity, assess the influence of study quality, and determine the robustness and stability of the meta-analysis results. The sensitivity analysis was performed by comparing the pooled prevalence ratios obtained from the fixed-effect model and the Restricted Maximum Likelihood (REML) model. The analysis was conducted according to the smallest number of studies included in the meta-analysis.

Table 8. Sensitivity Analysis Comparing Pooled Prevalence Ratios Using the Fixed-Effect Model and the Restricted Maximum Likelihood (REML) Model

No	Study Variables	N	*Heterogenity (p-value)*	*Fixed Effect*		*Restricteed ML*	
				PR	95% CI	PR	95% CI
1.	Hair Length as a Risk Factor for *Pediculosis capitis* Infestation	10	0,019	2,159	0,64 – 0,89	2,225	0,61 – 0,99
2.	Sex as a Risk Factor for *Pediculosis capitis* Infestation	13	< ,001	1,750	0,46 – 0,66	2,611	0,68 – 1,24
3.	Personal Hygiene as a Risk Factor for *Pediculosis capitis* Infestation	17	< ,001	1,599	0,40 – 0,55	1,915	0,44 – 0,86

Based on Table 8, variation among studies was observed for the independent variables, as indicated by an increase in the pooled PR values from the fixed-effect model to the Restricted Maximum Likelihood (REML) model, along with a widening of the confidence intervals. For the hair length and personal hygiene variables, the pooled PR values and confidence intervals obtained from the fixed-effect and REML models were relatively similar. In contrast, the sex variable demonstrated substantial between-study variation, as evidenced by a more pronounced increase in the pooled PR value from the fixed-effect model to the REML model, accompanied by a markedly wider 95% confidence interval.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the meta-analysis, the highest risk factor was sex, with a pooled PR value of $e^{0.96} = 2.611$ (95% CI: 0.68–1.24), followed by hair length, which was associated with a 2.225-fold increased risk. The lowest risk factor was personal hygiene, with a pooled PR value of $e^{0.65} = 1.915$ (95% CI: 0.44–0.86). Sensitivity analysis comparing the pooled PRs derived from the fixed-effect model and the Restricted Maximum Likelihood (REML) model demonstrated that the meta-analysis results were both relatively stable and relatively unstable across variables. Stable findings were observed for the hair length and personal hygiene variables, whereas the sex variable showed relatively unstable results.
The findings of this study highlight the need for interventions that are not only curative but also preventive and population-based. Policy implications include the integration of routine *Pediculosis capitis* screening into school health programs, strengthening standardized health education initiatives, and providing policy support to ensure the availability of safe and affordable pediculicides. From a public health practice perspective, cross-sector collaboration between healthcare services and educational institutions, along with the implementation of standardized management guidelines, represents an important strategy to reduce prevalence and prevent reinfestation. Future research should employ longitudinal

or interventional study designs with broader sample coverage to assess causal relationships, evaluate the effectiveness of preventive measures, and identify additional risk factors influencing the occurrence of *Pediculosis capitis*.

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