

A COMPREHENSIVE REVIEW OF EPIDEMIOLOGY, RESISTANCE AND TREATMENT OF *PEDICULUS CAPITIS* IN THAILAND

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Abstract

Background: Pediculosis capitis, or head lice infestation, is a significant public health issue in Thailand, particularly among school-aged children. Prevalences are high, ranging from 23% to over 80% in various communities. A significant challenge to control efforts is the widespread resistance to common chemical treatments, such as permethrin, caused by knockdown resistance (kdr) mutations. This situation calls for a review to address these challenges to guide public health policies.

Objective: This review aims to consolidate the current literature on the epidemiology, resistance, and treatment strategies for pediculosis capitis in Thailand, highlighting key findings and ongoing challenges.

Methods: A comprehensive search was conducted across five bibliographic databases: PubMed, Scopus, Web of Science, Thai Journals Online (ThaiJO), and Google Scholar, from which 15 relevant articles were selected for this review.

Results: Epidemiological studies confirm a high prevalence of head lice among Thai schoolchildren, reaching up to 83.9% in some areas, with girls being more frequently affected. Molecular studies detected a high frequency of kdr mutations (97.4%) in lice populations across Thailand, which are strongly linked to treatment failure for 1% permethrin lotion (failure rate of 47.5%). Alternative treatments have shown high effectiveness; oral ivermectin achieved a 94.8% cure rate, and 4% dimeticone demonstrated 100% mortality in ex vivo tests. A herbal shampoo demonstrated a 100% cure rate (compared to 3.3% for the placebo), and health education programs reduced the prevalence from 59.2% to 44.1%, while also improving knowledge and practices.

Conclusion: Pediculosis capitis remains a persistent challenge in Thailand, characterized by a high prevalence and significant resistance to permethrin. Alternative treatments, such as ivermectin and dimeticone, combined with health education, are effective ways to control the condition. Future efforts should focus on integrated strategies that combine molecular surveillance and community-based education to tackle drug resistance and the social factors that sustain infestations.

Keywords: Pediculosis capitis, Thailand, drug resistance, alternative treatment, health education

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Introduction

Pediculosis capitis, also known as head lice (*Pediculus humanus capitis*), remains a significant public health concern in Thailand, particularly among school-aged children and those residing in rural or resource-limited communities.⁽¹⁻⁵⁾ Studies show a high prevalence among Thai schoolchildren, ranging from 23% to over 80% in some regions.⁽¹⁻⁵⁾ A clear gender difference is consistently seen, with girls being more frequently infested than boys.⁽¹⁻⁵⁾ The persistence of head lice infestations is linked to a combination of behavioral, socioeconomic, and environmental factors, such as sharing combs, inadequate personal hygiene, and living in overcrowded conditions.^(1, 3, 4)

A significant challenge in controlling this issue is the increasing resistance of head lice to standard chemical treatments, especially permethrin. The reduced efficacy of pediculicides in Thailand is primarily attributed to the widespread occurrence of knockdown resistance (kdr). This resistance stems from point mutations in the voltage-gated sodium channel (VGSC) gene, the target site for pyrethroid and DDT insecticides. These mutations alter the channel's structure, which impedes effective binding of the insecticide. As a result, the compound's neurotoxic action is inhibited, rendering the lice resistant to treatment.^(6, 7)

This has necessitated the exploration of alternative treatments, including oral ivermectin, botanical products, and physically acting agents like dimeticone.^(1, 8, 9) alongside new treatments, health education programs have shown prom-

ise in reducing infestation rates by enhancing knowledge, attitudes, and practices among schoolchildren and their families.^(10, 11) This review consolidates the current literature on the epidemiology, resistance mechanisms, and treatment strategies for pediculosis capitis in Thailand, highlighting key findings and outlining ongoing challenges.⁽¹⁻¹¹⁾

Methods

We performed a comprehensive search across five bibliographic databases: PubMed, Scopus, Web of Science, Thai Journals Online (ThaiJO), and Google Scholar. The search strategy involved targeted queries on the epidemiology, resistance, and treatment of Pediculosis capitis in Thailand. Inclusion criteria required sources to be peer-reviewed academic papers published in English or Thai since 1995. Therefore, non-peer-reviewed sources were excluded from the review. We also included broader searches on regional and global data to provide context.

The initial search identified 1,034 papers. After removing duplicates, 469 articles were screened for eligibility. Out of these, 304 met the inclusion criteria, and the 15 most relevant papers were selected for this review. The search was organized into seven distinct groups focused on epidemiology, resistance, treatment, and intervention strategies for head lice in Thailand and Southeast Asia.

Results

Based on the 15 selected articles, a summary of the findings on pediculosis capitis in Thailand is presented in **Table 1**.

Table 1. Summary of the findings

Ref.	Population	Intervention or exposure	Comparison	Outcome
[1]	1,075 individuals in a rural Thai village	Oral ivermectin (200 µg/kg)	Not specified	94.8% cure rate after two doses; prevalence was 38.6%
[2]	1,221 schoolchildren in eastern Bangkok	Epidemiological survey	Male vs. Female students	Overall prevalence of 23.34%; higher in girls (27.56%) than boys (17.39%)
[3]	473 pre-high school girls in Pathum Thani	Epidemiological survey	-	Prevalence of 43.1%; identified risk factors and knowledge gaps

Table 1. Summary of the findings (Cont.)

Ref.	Population	Intervention or exposure	Comparison	Outcome
[4]	1,185 primary school children near the Thai-Myanmar border	Epidemiological survey	-	Prevalence of 83.9%; risk factors included female gender, long hair, and sharing combs
[5]	711 schoolchildren of Chinese refugees in northern Thailand	Epidemiological survey	-	Prevalence of 47.7%; higher in girls (64.5%) than boys (28.7%)
[6]	Head lice from 14 primary schools across Thailand	Molecular analysis for kdr mutations	-	97.4% of lice carried kdr mutations, primarily T917I
[7]	80 children with head lice in Nonthaburi Province	1% permethrin lotion	Lice with kdr genotype vs. lice without	Permethrin failure rate was 47.5%; kdr genotype was a strong predictor of treatment failure
[8]	Head lice collected from infested children in Thailand	4% dimeticone	Chemical pediculicides and botanical extracts	Dimeticone achieved 100% mortality <i>ex vivo</i> ; outperformed other treatments
[9]	60 schoolchildren in Thailand	Herbal shampoo from <i>Zanthoxylum limonella</i>	Placebo shampoo	100% cure rate at day 14 with the herbal shampoo vs. 3.3% with placebo
[10]	179 schoolgirls in Khon Kaen Province	Health education program	Pre- and post-intervention assessment	Infestation prevalence decreased from 59.2% to 44.1%; knowledge and practice scores improved
[11]	Not specified (focus on module development)	Development of a health education module	-	Describes the process for creating a health education module to improve KAP
[12]	Head lice from a single severe infestation case	Molecular screening for kdr gene	-	Lice were homozygous for the kdr T917I mutation
[13]	Head lice (<i>Pediculus humanus capitis</i>)	6-gingerol and <i>Cymbopogon citratus</i> extracts	Not specified (in vitro toxicity test)	Both botanicals showed high mortality against lice in vitro
[14]	Not specified (review of efficacy)	Herbal shampoo from <i>Cymbopogon citratus</i> and ultrasonic sound	Not applicable	Discusses the potential efficacy of the combined treatment method
[15]	30 female elementary students	Wet combing method	1% permethrin lotion	Wet combing was more effective (100% cure) than permethrin (86.67% cure) after 7 days

Epidemiological studies from various regions, including urban Bangkok and rural border areas, show a high prevalence of head lice among schoolchildren.⁽²⁻⁵⁾ Infestation rates are alarmingly high in some communities, reaching as high as 83.9%.⁽⁴⁾ A consistent finding across these studies is that girls are more affected than boys.^(2, 5) Widespread resistance to conventional chemical treatments presents a significant challenge in controlling infestations. Molecular research confirms a high prevalence of knock-down resistance (kdr) mutations in head lice populations throughout Thailand.^(6, 12) The presence of these genetic mutations is directly linked to the failure of 1% permethrin lotion, with one study reporting a treatment failure rate of nearly 50%.⁽⁷⁾

To overcome this resistance, researchers have tested several alternative treatments. A 4% dimeticone solution was 100% effective in

laboratory tests, surpassing other chemical and botanical options.⁽⁸⁾ Oral ivermectin also showed a high cure rate of over 94% in a community setting.⁽¹⁾ Botanical solutions, such as an herbal shampoo made from *Zanthoxylum limonella*, have demonstrated promise, with a 100% cure rate in one clinical study.⁽⁹⁾ Other plant-based extracts are also under study.^(13, 14) Additionally, a comparative study found that the physical method of wet combing was more effective than permethrin treatment.⁽¹⁵⁾

Public health interventions focused on education have also proven effective. A health education program for schoolgirls in Khon Kaen Province successfully lowered infestation rates and enhanced knowledge and practices related to head lice management.⁽¹⁰⁾ Developing structured health education modules is regarded as a key strategy to combat infestations.⁽¹¹⁾

Table 2. Matrix of research topics and study attributes for included papers.

Topic/ Outcome	Urban School- children	Rural School- children	Molecular Resistance	Alternative Treatments	Health Education
Prevalence	3	5	1	GAP	GAP
Resistance Mechanisms	1	2	4	GAP	GAP
Treatment Efficacy	2	3	1	3	1
Health Education Interventions	1	2	GAP	GAP	3
Social/Behavioral Factors	1	2	GAP	GAP	1

Table 2 provides a structured overview of the existing research, linking key topics to highlight both well-studied areas and notable knowledge gaps. The matrix utilizes numerical counts from the 15 selected references to illustrate the volume of literature for each subject.

The analysis highlights a strong research focus on the epidemiology of head lice, particularly regarding prevalence among rural^(1, 4, 5, 6, 9) and urban^(2, 3, 10) schoolchildren. Another well-documented area is treatment resistance, with three papers dedicated to molecular studies^(6, 7, 12) and others examining resistance in rural^(6, 9) and

urban⁽⁷⁾ groups. Treatment efficacy is also a key theme, with studies assessing various interventions in different settings^(1, 7, 9, 10, 15) and exploring alternative therapies.^(1, 8, 9, 13, 14)

Conversely, the matrix shows important research gaps, marked as “GAP.” There is a notable lack of research linking health education interventions to outcomes related to molecular resistance or the effectiveness of alternative treatments. Likewise, no studies have been found that connect infestation prevalence directly to the impact of alternative treatments or education programs. The matrix also points out a gap

in understanding how social and behavioral factors influence molecular resistance or the adoption of new treatments.

This systematic mapping shows that, although basic data on epidemiology and resistance are relatively robust, research has not yet thoroughly examined the combined effects of integrated health strategies, such as merging educational programs with new treatments in communities where traditional options are failing.

Discussion

The findings of this review emphasize that pediculosis capitis in Thailand is a complex public health challenge with multiple interconnected factors. Here, we summarize the evidence supporting six key claims regarding the epidemiology, treatment, and control of head lice in

Thailand, as presented in **Table 3**.

High prevalence of Pediculosis capitis among Thai schoolchildren

The literature confirms that head lice infestation is a persistent and widespread problem among Thai schoolchildren, with prevalence rates that are among the highest reported globally.⁽¹⁻⁵⁾ Studies consistently identify this as a significant public health concern,⁽³⁾ with prevalence varying regionally from 23% in urban Bangkok to over 80% in rural border areas.⁽¹⁻⁵⁾ A recurring theme is a significant gender disparity, with girls being more frequently and severely affected.^(1, 3, 5) This persistence is linked to risk factors such as sharing personal items, overcrowded living conditions, and inadequate hygiene.^(1, 3, 4)

Table 3. Key claims and supporting evidence

Claim	Evidence Strength	Reasoning	Papers
High prevalence of pediculosis capitis among Thai schoolchildren	Strong	Multiple large cross-sectional and community-based studies with consistent findings	[1-5]
kdr mutations are widespread and reduce permethrin efficacy	Strong	Molecular and clinical studies show strong association between kdr and treatment failure	[6-8, 12]
Dimeticone and ivermectin are effective alternatives to permethrin	Moderate	Clinical and ex vivo trials demonstrate high cure rates and safety	[1, 8]
Health education reduces infestation rates and improves KAP	Moderate	RCTs and intervention studies show significant improvements in knowledge and prevalence	[10, 8]
Botanical shampoos are promising but need more research	Moderate	In vitro and in vivo studies show efficacy, but limited by sample size and follow-up	[9, 13, 14]
Parental misconceptions and stigma hinder effective control	Weak	Survey and qualitative data highlight persistent knowledge gaps and social barriers	[3, 11]

Kdr mutations are widespread and reduce the efficacy of permethrin.

The spread of knockdown resistance (kdr) mutations has significantly reduced the effectiveness of first-line treatments, such as permethrin, leading to a shift toward alternative therapies.⁽⁶⁻⁹⁾ Molecular studies have confirmed a high occurrence of kdr mutations (e.g., T917I, L920F) throughout Thailand.^(6, 7, 12) The presence of these mutations is directly associated with treatment failure.⁽⁷⁾ For example, a clinical study in Nonthaburi province found that the kdr genotype was a strong predictor of permethrin failure, with an odds ratio of 13.15.⁽⁷⁾ This widespread resistance has led to permethrin cure rates dropping to around 50% in some regions,^(7, 8) making molecular surveillance crucial for guiding treatment decisions.^(6, 7)

Dimeticone and ivermectin are effective alternatives to permethrin.

With traditional treatments failing, physically acting agents like dimeticone and oral ivermectin have emerged as robust alternatives, demonstrating high efficacy and safety in both clinical and field settings.^(1, 8, 9) For instance, 4% dimeticone achieved 100% mortality in laboratory tests and has surpassed chemical options in clinical studies.⁽⁸⁾ Oral ivermectin is also a proven, safe, and effective treatment, especially useful in community-wide programs and areas with limited resources.⁽¹⁾ These options are essential for managing infestations where resistance is common.

Health education reduces infestation rates and improves KAP.

Health education interventions that focus on knowledge, attitudes, and practices (KAP) are an effective method for controlling head lice.^(10, 11) Programs targeting schoolchildren and their families have successfully reduced infestation rates by promoting preventive behaviors.⁽¹⁰⁾ For example, an initiative in Khon Kaen Province resulted in a decrease in infestation rates among schoolgirls from 59% to 44%, while also significantly improving KAP scores.⁽¹⁰⁾ These results highlight the importance of community-based

education in achieving long-term control and preventing reinfestation.^(10, 11)

Botanical shampoos are promising but need more research.

Botanical products, including shampoos made from native Thai plants, are promising supplementary treatments, especially in communities with limited access to commercial pediculicides.⁽⁹⁾ Shampoos made with plants like *Zanthoxylum limonella* have shown high cure rates with minimal side effects.⁽⁹⁾ Other botanicals, such as *Cymbopogon citratus*⁽¹⁴⁾ and 6-gingerol,⁽¹³⁾ have also been investigated. However, the evidence supporting these treatments is still developing.⁽⁹⁾ Many studies are limited by small sample sizes and a lack of long-term follow-up data, highlighting the need for more rigorous research.⁽⁹⁾

Parental misconceptions and stigma hinder effective control.

Effective head lice control is often hindered by social factors, including knowledge gaps among parents and the social stigma linked to infestation.^(3, 11) Widespread misconceptions about how lice are transmitted and treated contribute to the persistence of infestations.^(3, 11) This stigma can also discourage families from seeking help and correctly applying control measures.^(3, 11) Tackling these social barriers is a vital part of any comprehensive public health strategy.

Future Research Directions in Pediculosis Capitis Management

While our understanding of pediculosis capitis in Thailand has improved, this review highlights several essential gaps where more research is needed to improve control strategies.

First, current studies primarily focus on the short-term effectiveness of alternative treatments. To fully evaluate the long-term efficacy and safety of treatments such as dimeticone and ivermectin, longitudinal studies are necessary to examine their impact across Thailand's diverse populations and environments.

Second, to effectively manage drug resistance, research should focus on identifying the most

effective ways to integrate molecular resistance surveillance into routine public health practices. These systems are crucial for early detection of resistance, which can inform treatment strategies and prevent the spread of failures.

Finally, sociocultural factors continue to pose a significant obstacle. The stigma and misconceptions surrounding head lice can undermine the effectiveness of technical solutions. Therefore, research is necessary to identify the most effective methods for reducing stigma and promoting proactive parental involvement to address these social barriers.

Conclusion

Pediculosis capitis remains a persistent public health challenge in Thailand, driven by high prevalence among schoolchildren, widespread resistance to standard treatments, and ongoing knowledge gaps. This review demonstrates that alternative treatments, such as dimeticone and ivermectin, combined with targeted health education, offer promising options for improved control.

Despite these advances, significant research gaps still exist. There is a clear need for long-term evaluation of alternative therapies, integration of resistance monitoring into public health practices, and the development of scalable, culturally sensitive educational programs. Future efforts should focus on an integrated strategy that combines molecular surveillance with comprehensive community engagement. This approach will be crucial for addressing the dual challenges of drug resistance and social factors that contribute to infestation, ensuring that control measures are effective and sustainable.

Ethics approval and consent to participate

Not applicable. This article is a review of previously published literature and did not involve original data collection from human participants.

Consent to publication

Not applicable. The manuscript does not contain any person's data in any form.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

PS carried out the review process, wrote the initial draft, and all authors contributed to and approved the final version.

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