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Barriers to Vaccine Uptake and Proactive Strategies: A Mixed-method Study of MMR2 Coverage in Narathiwat Province, 2023

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Abstract

Measles remains a public health concern in Thailand's southern border provinces due to persistent vaccine hesitancy despite national elimination efforts. Narathiwat Province continues to report a high incidence of measles, reflecting challenges in vaccine accessibility, cultural acceptance, and operational barriers. This study aimed to identify factors associated with the uptake of the second dose of measles-mumps-rubella (MMR2) vaccine and to explore parental vaccine hesitancy in Narathiwat Province using a mixed-methods approach. The quantitative study utilized secondary data from a 2023 performance survey of 114 childhood state vaccination service units, assessing key operational factors such as target area identification, vaccine uptake rechecks, and supervisor encouragement. Logistic regression identified factors associated with achieving ≥95% MMR2 coverage. The qualitative study explored vaccine hesitancy among 19 mothers in low-coverage districts, identifying concerns about post-vaccination side effects, religious permissibility, and trust in vaccination services. Results indicated that service units with >60 target children had significantly higher odds of failing to achieve ≥95% MMR2 coverage (adjusted OR 6.98, 95% CI 1.46–33.23). Vaccine uptake rechecks and target area clearance were associated with improved coverage but did not reach statistical significance. Common reasons for vaccine hesitancy included fear of side effects, particularly fever, and religious concerns. To enhance coverage, mobile vaccination clinics and door-to-door strategies should be expanded, alongside strengthened public health communication addressing parental concerns. Collaboration with local religious authorities is crucial in fostering trust. Addressing both logistical and cultural barriers is essential for improving vaccine acceptance in high-burden areas like Narathiwat Province.

Keywords: measles, MMR, vaccine hesitancy, barriers to vaccination, mobile vaccination clinics, Narathiwat

Introduction

An estimated 107,500 measles-related deaths occurred worldwide in 2023, despite the availability of effective vaccines.[1] Between 2000 and 2023, the World Health Organization and its partners prevented an estimated 60 million measles-related deaths globally through routine immunization programs, supplementary immunization activities, and targeted outbreak response strategies.[2] In 2010, Thailand committed to eliminating measles, adopting a strategic plan (2020–2024) that aimed for over 95% coverage of the first dose of the measles–mumps–rubella (MMR) vaccine (MMR1) and the second dose (MMR2) by ages 1 and 3, respectively.[3] These vaccines are freely provided through Thailand's universal healthcare system, contributing to increase coverage and reduce measles cases nationwide.[4,5] However, the southern border provinces (Pattani, Yala, Narathiwat) continue to report higher measles incidence and mortality than the national average, reflecting persistent barriers to acceptance.[6] Unique cultural contexts, including a predominantly Muslim population adhering to "halal" principles, contribute to vaccine hesitancy.[7–10] Despite endorsements from

Islamic authorities, concerns about vaccine side effects and service quality further hinder vaccine uptake.[11–14] Additionally, some operational barriers that may affect poor vaccine coverage, such as excessive target children per service unit which can overwhelm staff capacity, and the process of entering vaccination data into the Health Data Center (HDC) system (a national platform providing vaccine uptake statistics updated regularly) which requires digital literacy and regular data entry. These factors may compromise the accuracy and timeliness of vaccine coverage reporting. Narathiwat, with the highest measles incidence rate in Thailand (97.5 per 100,000 population), faces significant challenges in MMR vaccine uptake, particularly in districts such as Rueso and Bacho, which report the lowest coverage in the province.[6,15,16] This study aimed to identify factors affecting MMR vaccine uptake rates in Narathiwat Province through two approaches: describing the practices of childhood state vaccination service units in a quantitative study, and interviewing parents whose children have not completed the MMR vaccine series in a qualitative study. Findings will inform recommendations to enhance immunization programs in the region.

Methods

We used a mixed-method approach, integrating both quantitative and qualitative studies.

Quantitative Study

We conducted a cross-sectional analytic study using secondary data from the 2023 performance survey of all 114 childhood state vaccination service units in Narathiwat Province, spanning every subdistrict in 13 districts. Most units were based in Sub-district Health Promotion Hospitals (SHPHs). The survey, conducted by the Narathiwat Provincial Public Health Office, assessed operational performance using structured questionnaires completed by primary vaccination staff. Key variables included target child numbers, confidence in identifying target areas via the HDC Program, frequency of area clearance and uptake rechecks, supervisor encouragement, reasons for vaccine hesitancy, and proactive vaccination strategies.

Descriptive statistics included median, interquartile range (IQR), frequency, and percentage. Univariable and multivariable logistic regression models identified factors associated with failing to achieve ≥95% MMR2 coverage, defined as children aged 3 years in fiscal year 2022 receiving their second MMR dose. Vaccine coverage data were obtained from the HDC program. Variables with a p-value <0.2 in univariable analysis were included in the multivariable model. Logistic regression results were reported as adjusted odds ratios (ORs) with 95% confidence interval (CI). The minimum sample size was calculated at 54 per group using the formula for comparing two proportions (significance level 0.05, power 0.85)[17], based on vaccination rates during the intervention (51%) and non-intervention (28%) seasons.[18] However, sampling was unnecessary as all 114 units were included.

Data were reviewed for completeness, cleaned, and analyzed using R version 4.2.1.[19] Personal data were excluded, per the Personal Data Protection Act 2019.

Qualitative Study

We gathered insights from mothers of children who turned three in fiscal year 2023 but had not completed MMR2. We focused on maternal beliefs, trust in the health system, and vaccination decisions. We interviewed mothers residing in Bacho and Rueso districts.

Purposive sampling selected five service units with the lowest MMR2 coverage in each district (five SHPHs in Bacho, four SHPHs and one hospital in Rueso). Two mothers per unit were randomly chosen from local registries, yielding 20 participants. However, one could not be reached, resulting in 19 completed interviews.

Semi-structured, in-depth interviews were conducted in private settings for 30–60 minutes. When participants were more comfortable communicating in Malay, the interviews were conducted in the Malay language. All responses were recorded with consent. All interviews were conducted by trained village health volunteers (VHVs) from the Narathiwat Provincial Health Office. These VHVs had prior experience from the DRIVE Demand Thailand project and received additional training in interview techniques and ethics.[20] A pilot was conducted before data collection. Given their strong community ties and established trust, VHVs were well-positioned to elicit honest, low-bias responses on this sensitive topic. Thematic analysis was performed, and key quotes for each theme were collated and reviewed.

Result

Quantitative Results

Factors affecting MMR2 vaccine uptake in Narathiwat Province were identified by comparing units with at least coverage 95% (n=16) to those with coverage less than 95% (n=98). As shown in Table 1, service units with more than 60 target children had significantly higher odds of failing to achieve ≥95% MMR2 coverage compared to those with fewer than 60 children (adjusted OR 6.98, 95% CI 1.46–33.23, p <0.05).

Although not statistically significant, some factors showed trends related to higher MMR2 coverage. These included the use of mobile clinics or door-to-door services compared to vaccination events. In contrast, lower coverage trends were observed in units that lacked confidence in identifying target areas within the HDC program, performed less frequent clearance of target areas, or conducted HDC vaccine uptake status rechecks less frequently after administering vaccines. Compared to time constraints, distrust in vaccines, religious concerns, and fear of side effects, particularly fever, were more likely to be the primary reasons for vaccine hesitancy.

As shown in Figure 1, fear of side effects was the most frequently reported reason for vaccine hesitancy across all districts. In Rueso District, distrust in vaccines was also a notable concern, while Si Sakhon District showed time constraints as a secondary barrier, followed by religious (non-halal) concerns. Bacho District showed a more balanced mix of concerns, including distrust in vaccines and religious (non-halal) issues. Cho-airong District (55% coverage) reported almost exclusively fear of side effects, without notable concern for other barriers. Conversely, districts with the highest MMR2 coverage reported fewer barriers, with time constraints being the only moderate issue.

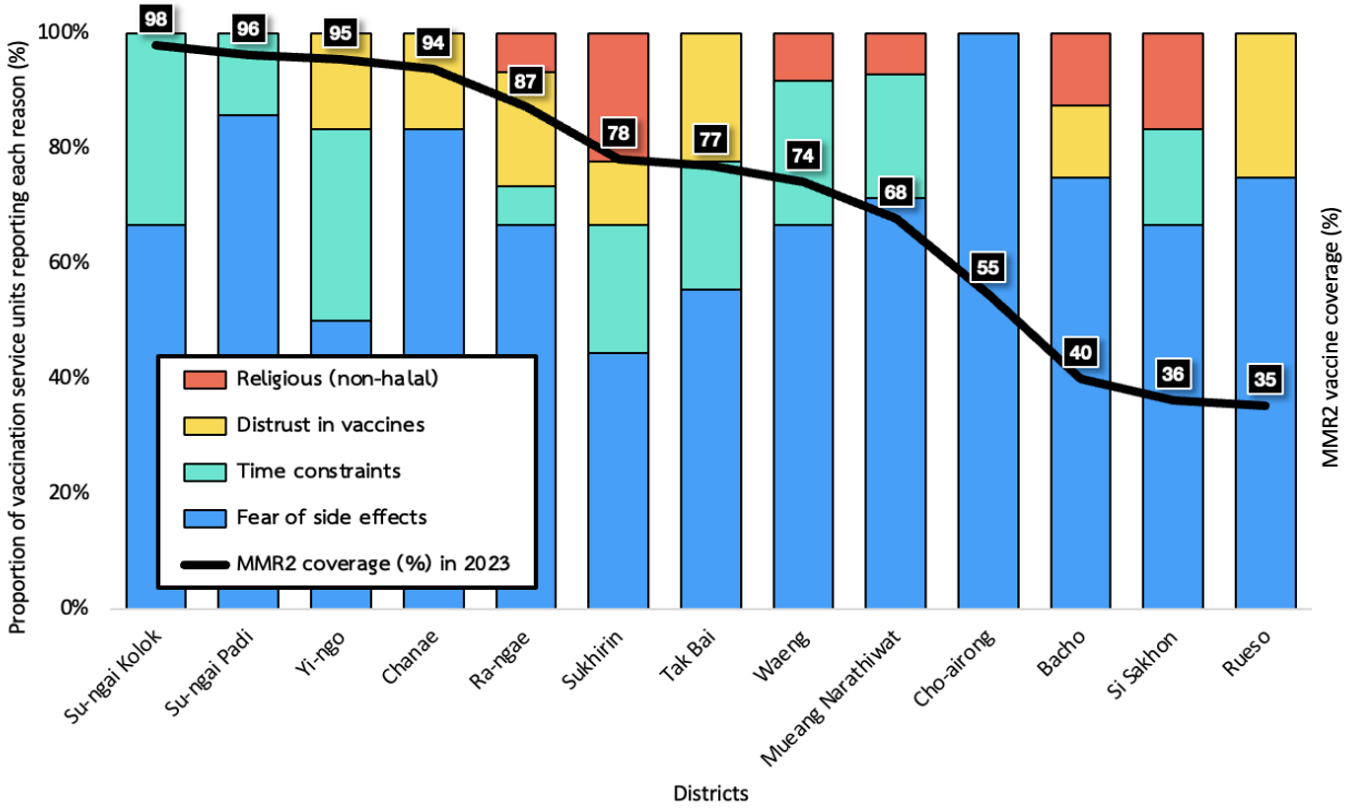

Figure 1. Reasons for MMR2 vaccine hesitancy reported by childhood state vaccination service units and corresponding MMR2 coverage by district, Narathiwat Province, 2023 (n=114)

From Table 1, each of the 114 childhood state vaccination service units reported their most commonly used proactive strategy to enhance vaccine uptake. The three main approaches were: mobile vaccination clinics (55/114, 48.2%), door-to-door visits (25/114, 21.9%), and vaccination events at health facilities (18/114, 15.8%).

Qualitative Results

All 19 mothers of children who turned three years old in Rueso and Bacho districts and had not completed the MMR2 in fiscal year 2023 were interviewed. The number of mothers in Rueso District was seven, with a median age of 33 years (IQR 27.5–37.5), while in Bacho District, the number was 12, and the median age was 32.5 years, with an IQR of 27.8–39.3. The overall median age of the 19 participating mothers across both districts was 33 years (IQR 27.5–39.5). These characteristics provide a foundation for understanding the perspectives and challenges faced by mothers in these districts regarding MMR2 vaccination. We identified six main themes from the interviews.

Table 1. Factors associated with failing to achieve ≥95% MMR2 coverage by childhood state vaccination service units in Narathiwat Province, 2023 (n=114)

Variable	MMR2 coverage <95% (n=98)	MMR2 coverage ≥95% (n=16)	Univariable	Multivariable
			Crude OR (95% CI)	Adjusted OR (95% CI)
Child target per unit				
>60	51	2	7.60 (1.64–35.20)*	6.98 (1.46–33.23)
≤60	47	14	Ref	
Confidence in the accuracy of target area identification within the HDC program				
No	42	3	3.25 (0.87–12.13)*	2.47 (0.60–10.20)
Yes	56	13	Ref	
Frequency of clearing target area type				
Monthly	34	8	Ref	
Quarterly	35	7	1.18 (0.38–3.60)	1.01 (0.31–3.32)
Yearly	29	1	6.82 (0.81–57.83)*	3.52 (0.38–32.87)
HDC vaccine uptake status rechecks				
Others	7	1	1.15 (0.13–10.06)	
Self	91	15	Ref	
Frequency of HDC vaccine uptake status rechecks				
Weekly	50	11	Ref	
Monthly	32	4	1.76 (0.52–6.01)	
Every 3 months	16	1	3.52 (0.42–29.42)	
Supervisor encouragement for vaccination efforts				
No	5	1	0.81 (0.09–7.38)	
Yes	93	15	Ref	
Main reason for vaccine hesitancy				
Time constraints	7	2	Ref	
Fear of side effects	74	12	1.76 (0.33–9.51)	
Distrust in vaccines	10	1	2.86 (0.21–38.00)	
Religious (non-halal)	7	1	2.00 (0.15–27.45)	
Proactive vaccination strategy most commonly used by childhood state vaccination service units to enhance uptake†				
Vaccination events at health facilities	18	1	Ref	
Door-to-door visits	25	7	0.38 (0.04–3.27)	
Mobile vaccination clinics	55	8	0.20 (0.02–1.76)	

**Variables with p-value <0.2 in univariable analysis were selected for inclusion in the multivariable model. †Vaccination events at health facilities targeted larger groups through special drives; Door-to-door visits reached households in areas with limited mobility; Mobile vaccination clinics were arranged within communities to improve access. HDC: Health Data Center. OR: odds ratio. CI: confidence interval. Ref: reference.*

Perceptions of Measles

Most participants recognized measles as a contagious viral illness marked by distinct symptoms such as red rashes and fever. However, their depth of understanding regarding the severity, progression, and other associated symptoms of the disease varied widely. While some participants provided detailed descriptions of the rash and the extent of spread, others perceived the condition as mild or were unfamiliar with it.

"Red rash with low fever." ...A1–3, A5, B1–4, B10, B12

"Red patches on the body spreading to the legs when having a fever." ...A4, A7, B7–8

"My child had small itchy red spots; it didn't seem too severe." ...B5

"I don't know it because this disease isn't common in my area." ...B11

Effectiveness of Vaccine

Participants recognized the benefits of vaccination in preventing disease and reducing severity. Most participants emphasized the vaccine's role in minimizing severe symptoms and preventing disease progression, demonstrating confidence in its effectiveness. Several participants also acknowledged its life-saving potential, noting that it can reduce the risk of death and increase immunity. However, some participants expressed more cautious views, acknowledging that while the vaccine offers protection, it may not fully prevent severe outcomes or infection.

"It helps prevent the disease and reduce severe symptoms." ...A1–3, A5–7, B1, B2, B5, B7–10

"It prevents death and provides immunity." ...A4, B4, B11

"It provides some protection." ...B6, B12

Support for Vaccination Campaigns

Participants highlighted the importance of vaccination campaigns in preventing diseases, especially measles. Most described the campaigns as effective in promoting awareness and increasing acceptance of measles vaccination within the community. One participant noted that while the campaigns were beneficial, some children might still become infected, suggesting a residual concern about vaccine effectiveness. However, overall feedback reflected strong support for the campaigns themselves rather than doubts about the vaccines.

"Vaccination campaigns are important because they encourage parents to vaccinate their children." ...A1–7, B1–3, B5–8, B10, B11

"the campaigns are good, but some children might still get infected." ...B12

Barriers to Vaccination Uptake

Participants highlighted various concerns regarding vaccination, reflecting a mix of fears, logistical challenges, and personal beliefs. A common worry was the potential for post-vaccination fever or more severe side effects such as paralysis, which some feared as being a disruption to their work or daily responsibilities. Time constraints due to work were also frequently mentioned. Additionally, personal beliefs, such as reliance on hygiene and diet for disease prevention or doubts about the halal status of vaccines, influenced vaccine hesitancy for some.

"I fear my child will get a fever afterward." ...A1–3, A5, A7, B1, B2, B8, B9

"If my child gets sick, it disrupts my work." ...A4, B3, B7

"I'm afraid of side effects, like paralysis, which would make our life harder." ...A6, B12

"I'm waiting until my child is a bit older." ...B11

"I don't have time because of working Monday to Friday." ...B4, B10

"I think maintaining hygiene and eating fresh food can prevent diseases, so vaccination isn't necessary." ...B6

Perceptions of Halal Status of Vaccines

Participants expressed a range of perspectives regarding the halal status of vaccines, emphasizing the importance of trusted sources and clear communication. Many participants highlighted the need for confirmation from health authorities to ensure the vaccine complies with religious principles. While some participants were confident that the vaccine was halal, others expressed hesitancy due to rumors or uncertainty.

"I need confirmation from health authorities." ...A1, A3, A5–7, B1, B4, B6, B8

"It is halal." ...A2, B2, B3, B7, B9–12

"I'm hesitant because people have mentioned it might not be halal." ...B5

Trust in Local Vaccination Services

Participants expressed varying levels of trust in vaccination services, with the majority indicating strong confidence in the system. However, some raised concerns about specific issues, such as side effects, staff behavior, or perceived inexperience among healthcare providers. While most participants trusted the services, frustrations arose from experiences of being reprimanded for missed appointments.

"I trust them." ... A4, A6, B1, B2, B4, B7, B8, B10, B12

"I trust them somewhat but worry about side effects." ...A7, B3, B5

"There are many inexperienced nurses." ...A5

"They complain if I miss appointments." ...A1–3, B6

Discussion

This study identified both service and demand-side factors influencing MMR2 coverage in Narathiwat. Units with more than 60 target children were significantly less likely to reach ≥95% coverage, suggesting that heavy workloads reduce performance. Trends also pointed to higher coverage in units using mobile clinics, door-to-door visits, and more consistent data practices, particularly by regularly clearing target area data and performing self-rechecks of vaccine uptake status using the HDC system. On the demand side, fear of side effects, concerns about vaccine content, and halal status remained key barriers, underscoring the need for both operational and cultural solutions. Hesitancy was largely driven by prior experiences of illness after vaccination, consistent with previous findings.[21,22] Although the MMR vaccine significantly lowers the incidence of post-vaccination fever compared to other vaccines such as Diphtheria, Tetanus, and whole-cell Pertussis and Japanese Encephalitis in Thailand's Expanded Program on Immunization schedule,[23,24] many mothers generalized their concerns to all vaccines. However,

this alone does not account for the high level of vaccine hesitancy in Narathiwat, as similar vaccines are used in other regions without similar resistance, indicating other sociocultural and economic factors. Economic barriers emerged as a critical concern, with mothers expressing fear of side effects—such as fever after vaccination—that could disrupt their work and lead to financial instability. This aligns with studies indicating that socio-economic challenges, such as poverty and limited access to economic resources, significantly impact vaccine uptake.[9,10,12] These challenges are intensified in Narathiwat, which faces long-standing economic hardship.[25] Similar challenges have been reported in other countries, where economic constraints exacerbate vaccine hesitancy.[26–28]

In Narathiwat, where most parents are Muslim, concerns about the halal status of vaccines and beliefs that vaccination may contradict Islamic teachings contribute significantly to hesitancy. Similarly, in other Muslim-majority countries, misconceptions about the religious permissibility of vaccines often foster distrust and influence parental decisions regarding immunization.[29] Islam prohibits the consumption of pork, and some vaccines use gelatin derived from pork products as a stabilizing agent.[30] However, Islamic jurisprudence prioritizes the preservation of life and permits vaccines derived from non-halal sources when no halal alternatives are available.[31] Jurisprudence councils generally deem vaccines permissible if they undergo transformation and purification processes.[32] Additionally, most Islamic scholars support vaccination as a public health necessity, based on the principle that necessities override prohibitions.[33] In Thailand, measles vaccines do not contain pig-derived ingredients, including porcine gelatin, as confirmed by the Director of the Division of Communicable Diseases, Ministry of Public Health, Thailand.[34] Nonetheless, this study found that some mothers still seek confirmation from health authorities about the halal certification of vaccines, beyond endorsements from the Central Islamic Council of Thailand. To address this, health agencies must take the lead in collaborating with the Central Islamic Council of Thailand and global or national halal certification bodies to provide credible and unified certification.

Mobile vaccination clinics have effectively improved coverage, and expanding this strategy to underserved areas could further boost uptake by addressing logistical barriers.[35] This is supported by our qualitative findings, where some participants reported challenges such as a lack of time due to work schedules. Our quantitative study also suggested a trend toward higher MMR2 coverage in units using mobile vaccination clinics, although this association was not statistically significant. These factors underscore the need for more accessible service delivery models. However, challenges persist, especially for staff managing large child populations. High workloads can hinder the accuracy of vaccination records and reduce the quality of client counseling. This aligns with our finding that units with over 60 target children were less likely to achieve high MMR2 coverage, suggesting that heavy workloads may hinder performance. Consistent with international studies, limited workforce capacity undermines the efficiency of immunization programs.[36] Furthermore, communication barriers, particularly when engaging with mothers who refuse or delay vaccination, also persist.

Other operational barriers, such as lack of confidence in identifying target areas and infrequent clearance of target areas (i.e., updating and verifying target population data), showed trends toward lower MMR2 coverage but were not statistically significant. These findings align with studies highlighting the importance of timely follow-up checks of immunization data, the frequency of these reviews, and supervisor support for accurate coverage.[37,38] Clearing target areas and updating population records are also crucial for improving MMR2 coverage and overcoming barriers.[39,40]

Limitations

While the quantitative component included all state vaccination service units and provided broad representativeness, the qualitative component was limited to 19 mothers from only two districts. This may limit the generalizability of maternal perspectives. Future studies should consider including fathers or other caregivers to better capture parental decision-making.

Recommendations

To strengthen service delivery, mobile vaccination clinics and door-to-door outreach services should be expanded especially in underserved areas. As units with more than 60 target children were significantly less likely to achieve high MMR2 coverage, reducing workforce burden is crucial. Optimizing core practices such as more frequent area clearance and self-rechecks of vaccine uptake data may also lead to better outcomes.

To reduce vaccine hesitancy among parents, communication strategies should emphasize that mild side effects like fever are temporary and far less severe than complications from non-vaccination. Conducting studies comparing the burden of post-vaccination side effects with the risks of not vaccinating would strengthen these efforts. Although the halal status of vaccines is clarified nationally, local health authorities should collaborate with religious leaders to address

concerns while improving provider communication to build trust and confidence in the vaccine program.

Conclusion

This study highlights several factors affecting MMR2 coverage in Narathiwat Province, particularly challenges related to service delivery. Mobile vaccination clinics and door-to-door outreach were key strategies for improving access, especially in areas with high target populations. Operational issues such as limited workforce capacity, infrequent clearance of target areas, and self-rechecks of vaccine uptake status also affected MMR2 coverage. On the demand side, the main barrier was concern over post-vaccination fever, while cultural concerns like the halal status of vaccines played a lesser but persistent role. Improving MMR2 coverage requires strengthening local service systems, optimizing operational practices, and addressing parental concerns through culturally appropriate engagement.

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Author Contributions

Farooq Phiriyasart: Conceptualization, methodology, formal analysis, writing—original draft, writing—review & editing, supervision, and project administration. **Arisman Kariya:** Investigation, data curation, and validation. **Nungrutai Ninlakan:** Resources, data curation, and writing—review & editing. **Saowanee Mueankhaw:** Investigation, resources, and writing—review & editing. **Sasikarn Nihok:** Data curation and visualization. **Adul Binyusoh:** Supervision, resources, and writing—review & editing.

Ethical Approval

This study was approved by the Human Research Ethics Committee of the Narathiwat Provincial Health Office, Narathiwat Province, Thailand, under research code 29/66. The research protocol strictly adhered to international standards. All participants provided informed consent to participate in the study and were given an information sheet detailing the study.

Informed Consent

Informed consent was obtained from all participants involved in the study. Written informed consent was obtained from all participants prior to the interviews.

Data Availability

The data that support the findings of this study are available from the Narathiwat Provincial Public Health Office. Restrictions apply to the availability of these data, which were used under license for this study. Data are available from the corresponding author with the permission of the Narathiwat Provincial Public Health Office.

Conflicts of Interest

The author declares no conflicts of interest related to this work.

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Declaration of Generative AI and AI-assisted Technologies in the Writing Process

During the preparation of this work, the authors used ChatGPT (OpenAI) to enhance clarity and correct grammatical errors. The content produced by this tool was reviewed and edited by the authors, who accept full responsibility for the final text.

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References

1. World Health Organization. Measles [Internet]. Geneva: World Health Organization; 2024 Nov 14 [cited 2025 Apr 7]. <https://www.who.int/news-room/fact-sheets/detail/measles>
2. Minta AA, Ferrari M, Antoni S, Lambert B, Sayi TS, Hsu CH, et al. Progress toward measles elimination — worldwide, 2000–2023. MMWR Morb Mortal Wkly Rep. 2024 Nov 14; 73(45):1036–42. doi:10.15585/mmwr.mm7345a4.
3. Division of General Communicable Diseases, Department of Disease Control, Ministry of Public Health. Strategic plan for measles and rubella elimination in Thailand 2020–2024 [Internet]. Nonthaburi: Division of General Communicable Diseases; 2021 [cited 2024 Jan 12]. 20 p. <https://ddc.moph.go.th/uploads/publish/1157820210624085758.pdf>. Thai.

4. Phonboon K, Shepard DS, Ramaboot S, Kunasol P, Preuksaraj S. The Thai expanded program on immunization: role of immunization sessions and their cost-effectiveness [Internet]. Bull World Health Organ. 1989 [cited 2024 Jan 20];67(2):181–8. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2491241/?page=1>

5. Regional Office for South-East Asia, World Health Organization. Expanded Program on Immunization (EPI) factsheet 2023: Thailand [Internet]. Geneva: World Health Organization; 2023 Dec 25 [cited 2024 Feb 15]. 6 p. <https://www.who.int/publications/i/item/Thailand-EPI-Factsheet-2023>

6. Somphan C, Chaiya S, Duang-ngern P. Measles situation report 2019–2020 [Internet]. Nonthaburi: Division of Epidemiology, Department of Disease Control, Ministry of Public Health; 2020 [cited 2024 Feb 20]. 6 p. <https://ddc.moph.go.th/uploads/files/1245620200417062235.pdf>. Thai.

7. Southern Border Strategic Development Group. Southern Border Provincial Development Plan 2019–2022 [Internet]. Bangkok: Office of the Permanent Secretary, Ministry of Interior; 2019 [cited 2024 Mar 29]. <https://www.osmsouth-border.go.th/files/com_news_plan/2019-05_768e0cbd1cb23f8.pdf>. Thai.

8. Phitsuwan W. Factors affecting the importance of halal certification among Muslim consumers in the four southern provinces of Thailand [Internet]. Bangkok: Bangkok University; 2002 [cited 2024 Mar 30]. <http://dspace.bu.ac.th/jspui/handle/123456789/3511>

9. Daya S, Lillahkul N, Noin J, Maharmud N. Development of a parent empowerment model in receiving service of the expanded program on immunization with vaccines of children aged 0–5 years old through community participation: a case study in Yala Province. J DMS [Internet]. 2019 [cited 2024 Apr 2];44(1):113–8. <https://he02.tci-thaijo.org/index.php/JDMS/article/view/24703>

10. Domang R, Prateepko T. Factors affecting parents on seeking basic immunization program for their children aged 0–5 years in Pattani province. J Health Sci Thai [Internet]. 2019 [cited 2024 Apr 5];28(2):224–35. <https://thaidj.org/index.php/JHS/article/view/6414>

11. Sheikhul Islam Office. Fatwa on COVID-19 vaccination [Internet]. Bangkok: Sheikhul Islam Office; 2021 [cited 2024 May 12]. 1 p. <https://cache-igetweb-v2.mt108.info/uploads/images-cache/520/filemanager/8005ae649f62d1e50054bc86a264d636.pdf>. Thai.

12. Jinarong T, Chootong R, Vichitkunakorn P, Songwathana P. Muslim parents' beliefs and factors influencing immunization of children in Thai rural communities: a qualitative study. BMC Public Health. 2023 Jul 13;23(1):1348. doi:10.1186/s12889-023-15273-y.

13. Sa-idi A. A phenomenological study on the refusal of vaccines for children among people in the Tungyangdaeng district of Pattani province. Bangkok: Faculty of Medicine, Ramathibodi Hospital, Mahidol University; 2019.

14. Apiwachaneewong S, Thammapalo S, Phetchatree S, Musow A. Success factors of immunization programs in southern border provinces, Thailand. J Health Sci [Internet]. 2019 Apr 30 [cited 2024 Jun 11];28(2):263–72. <https://thaidj.org/index.php/JHS/article/view/6418>

15. Health Data Center of the Ministry of Public Health (TH). Vaccination coverage of children aged 3 years receiving MMR2 in Narathiwat Province 2023 [Internet]. Nonthaburi: Information Technology and Communication Center, Office of the Permanent Secretary, Ministry of Public Health; 2023 [cited 2024 Jan 20]. <https://hdc.moph.go.th/center/public/standard-report-detail/267ce09f2a704eb7783997e25d1f18ba>. Thai.

16. Division of Epidemiology, Department of Disease Control. Measles situation report in Thailand, 2018–2019 (data as of December 27, 2019) [Internet]. Bangkok: Department of Disease Control, Ministry of Public Health; 2019 [cited 2024 Jan 20]. 5 p. <https://ddc.moph.go.th/uploads/files/1112120200121052809.pdf>. Thai.

17. Ngamjarus C, Pattanittum P. n4Studies: Sample size calculation in health sciences. [Khon Kaen]: n4Studies; 2023.

18. Lee I, Thompson S, Lautenbach E, Gasink LB, Watson B, Fishman NO, et al. Effect of accessibility of influenza vaccination on the rate of childcare staff vaccination. Infect Control Hosp Epidemiol [Internet]. 2008 [cited

2024 Jul 25];29(5):465–7. <https://pmc.ncbi.nlm.nih.gov/articles/PMC3697428/>

19. R Development Core Team. R Project for statistical computing. Version 4.2.1. Vienna: R Foundation; 2022.

20. Digital Square at PATH. Digital results improve vaccine equity and demand (DRIVE demand) – Thailand [Internet]. Washington (DC): Digital Square; 2024 [cited 2025 Apr 5]. 4 p. <https://static1.squarespace.com/static/59bc3457ccc5c5890fe7cacd/t/667f1f2eaacbdf48523064b8/1719607087786/DRIVE-Demand_factsheet_THAILAND.pdf>

21. Gungor B, Koparan S. Parental vaccine hesitancy: Which childhood vaccines were refused and why? Akdeniz Tıp Derg [Internet]. 2024;10(3):506–13. <https://doi.org/10.53394/akd.1340997>

22. Kaufman J, Tuckerman J, Bonner C, Durrheim DN, Costa DSJ, Trevena L, et al. Parent-level barriers to uptake of childhood vaccination: A global overview of systematic reviews. BMJ Glob Health [Internet]. 2021 [cited 2024 Dec 25];6(9):e006860. https://gh.bmj.com/content/6/9/e006860

23. Division of Epidemiology, Department of Disease Control, Ministry of Public Health. Surveillance and response guideline for adverse events following immunization, Thailand [Internet]. Nonthaburi: Division of Epidemiology; 2020 [cited 2024 Sep 1]. 118 p. <https://ddc.moph.go.th/uploads/publish/1144920210524022452.pdf>

24. Takhsha N, Taherpour M, Asadi M, Arab Taheri M. MMR and DTP vaccination side effects in children under 18 months in Bojnurd. North Khorasan University of Medical Sciences. 2015;6(4):745–53. doi:10.29252/jnkums.6.4.745.

25. The Nation. Bangkok: 6 provinces in Thailand suffer persistent poverty, as gaps get smaller in some, NESDC report reveals [Internet]. Bangkok: The Nation; 2023 Dec 17 [cited 2024 Apr 19]. <https://www.nationthailand.com/thailand/40033884>

26. Czapanskiy KS. Vaccination, disabled children, and parental income. Journal of Health Care Law and Policy [Internet]. 2021 [cited 2024 Sep 26];24(1):59–88. <https://typeset.io/pdf/vaccination-disabled-children-and-parental-income-516aznpzsv.pdf>

27. Khattak FA, Rehman K, Shahzad M, Arif N, Ullah N, Kibria Z, et al. Prevalence of parental refusal rate and its associated factors in routine immunization by using WHO vaccine hesitancy tool: A cross-sectional study at district Bannu, KP, Pakistan. Int J Infect Dis. 2021;104:117–24. doi:10.1016/j.ijid.2020.12.029.

28. Mohd Azizi FS, Kew Y, Moy FM. Vaccine hesitancy among parents in a multi-ethnic country, Malaysia. Vaccine. 2017;35(22):2955–61. doi:10.1016/j.vaccine.2017.04.010.

29. Samsudin K, Abdul Manaf R, Mahmud A. Childhood vaccine hesitancy in selected Islamic and Muslim-majority countries: result synthesis from a scoping review. IMJM [Internet]. 2023 [cited 2025 Jan 19];22(3). <https://journals.iium.edu.my/kom/index.php/imjm/article/view/2179>. doi:10.31436/imjm.v22i3.

30. Sirithammaphan U, Chaisang U, Pongrattanamarn K. Barriers to measles-mumps-rubella vaccine acceptance in the three southern border provinces of Thailand. Clin Exp Vaccine Res [Internet]. 2023 [cited 2025 Jan 19];12(4):298–303. <https://pmc.ncbi.nlm.nih.gov/articles/PMC10655155/>. doi:10.7774/cevr.2023.12.4.298.

31. Amin AM, Gunay HM. The role of istihalah (transformation) and istihlak (consumption) in the permissibility of vaccines derived from forbidden origins: An Islamic law perspective. Helal ve Etik Araştırmalar Derg [Internet]. 2023 [cited 2024 Dec 26];5(2):1–23. <https://doi.org/10.51973/head.1338259>

32. Bokek-Cohen Y, Gonen LD, Tarabeih M. The Muslim patient and medical treatments based on porcine ingredients. BMC Med Ethics [Internet]. 2023 [cited 2024 Dec 26];24(1):89. <https://doi.org/10.1186/s12910-023-00975-0>

33. Alsuwaidi AR, Hammad HAA-K, Elbarazi I, Sheek-Hussein M. Vaccine hesitancy within the Muslim community: Islamic faith and public health perspectives. Hum Vaccin Immunother [Internet]. 2023 [cited 2024 Dec 26];19(1):2190716. <https://doi.org/10.1080/21645515.2023.2190716>

34. Associated Press. Muslim concern about vaccine fuels measles outbreak. Bangkok Post [Internet]. Bangkok: Bangkok Post; 2018 Nov 6 [cited 2024 Dec 12]. <https://www.bangkokpost.com/thailand/general/1571030/muslim-concern-about-vaccine-fuels-thai-measles-outbreak>

35. Kazi AM, Ahsan N, Mughis W, Jamal S, Allana R, Raza M, et al. Usability and acceptability of a mobile app for behavior change and to improve immunization coverage among children in Pakistan: A mixed-methods study. Int J Environ Res Public Health. 2021;18(18):9527. doi:10.3390/ijerph18189527.

36. Chesoli RN, Schuster RC, Okelo S, Omotayo MO. Strengthening care delivery in primary care facilities: perspectives of facility managers on the immunization program in Kenya. Int J Health Policy Manag. 2018;7(12):1130–7. doi:10.15171/ijhpm.2018.83.

37. Mavimbe JC, Braa J, Bjune G. Assessing immunization data quality from routine reports in Mozambique. BMC Public Health. 2005;5:108. doi:10.1186/1471-2458-5-108.

38. Crocker-Buque T, Edelstein M, Mounier-Jack S. Routine vaccination program implementation in GP practices: A process evaluation. Implement Sci. 2018;13(1):132. doi:10.1186/s13012-018-0824-8.

39. Stashko L, Dumolard L, Danovaro-Holliday MC. Assessing the quality of national immunization program estimates. PLOS ONE. 2019 [cited 2024 Jul 5];14(7):e0216933. <https://doi.org/10.1371/journal.pone.0216933>

40. Granerod J, White J, Andrews N, Crowcroft NS. Vaccine coverage in England: impact of health service reorganization. Arch Dis Child [Internet]. 2006 [cited 2024 Jul 10];91:805–7. <https://typeset.io/pdf/vaccine-coverage-in-england-the-impact-of-health-service-19oq6xjf7z.pdf>. doi:10.1136/adc.2005.088625.