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Editorial

Urban Epidemiology in the 21st Century

Alden Henderson, Senior Editor

Urban epidemiologists investigate the patterns, causes, and effects of health and disease conditions in urban populations. This area of study has never been more critical because more than half of the world's population now living in cities. The unique characteristics of urban environments—including high population density, diverse demographics, and significant environmental exposures—pose distinct challenges and opportunities for public health.

The Urban Health Landscape

Cities are vibrant hubs of activity and innovation and these activities are conducive for the development and spread of diseases. The urban setting has a mix of communicable and non-communicable diseases that are influenced by socio-economic, environmental, and infrastructural factors. Two of the articles in the current issue of OSIR occurred in prisons which has characteristics of the urban environment.

Communicable Diseases

- *Respiratory infections:* Cities with high population densities can facilitate the rapid spread of respiratory diseases such as influenza, tuberculosis, and, most recently, COVID-19. The close quarters of urban living, combined with high mobility and frequent social interactions, as well as poor indoor ventilation make cities hotspots for outbreaks.
- *Vector-borne diseases:* Urban areas, particularly in developing countries, are prone to vector-borne diseases like dengue, Zika, and chikungunya. Poor sanitation, standing water, and inadequate waste management can create breeding grounds for mosquitoes and other vectors.

Non-communicable Diseases

- *Cardiovascular diseases:* Urban lifestyles often involve poor diet, lack of physical activity, and high-stress levels, contributing to the prevalence of hypertension, coronary artery disease, and stroke. The built environment is not conducive to green and open spaces for recreation.
- *Respiratory conditions:* Air pollution is a significant urban health hazard. Chronic exposure to pollutants can lead to asthma, chronic obstructive pulmonary disease, and other respiratory illnesses.
- *Mental health disorders:* The fast-paced, high-stress urban environment can exacerbate mental health issues such as depression, anxiety, and substance abuse disorders. Social isolation, despite the high population density, can also contribute to these conditions.

Lifestyle-related Conditions

- *Diabetes and obesity:* Urban areas often have better access to food but also higher availability of unhealthy food options. Combined with sedentary lifestyles, this leads to higher rates of obesity and type 2 diabetes.
- *Cancer:* Lifestyle factors prevalent in urban areas, such as smoking, alcohol consumption, and exposure to environmental carcinogens, contribute to the increased incidence of various cancers.

Role of Public Health and Epidemiology in Describing Urban Health Problems

Public health and epidemiology play critical roles in identifying, understanding, and addressing urban health challenges.

- *Data collection and analysis:* Epidemiologists gather and analyze data on disease incidence, prevalence, trends, and susceptible urban populations. This data helps identify emerging health threats, track disease outbreaks, and monitor trends over time.
- *Risk factor identification:* By studying patterns and causes of diseases, epidemiologists can pinpoint specific risk factors associated with urban living, such as air pollution, sedentary lifestyles, and poor diet. Understanding these risk factors is crucial for developing targeted interventions.
- *Health disparities research:* Urban environments often exhibit significant health disparities based on socio-economic status, race, and ethnicity. Public health research highlights these disparities and informs policies aimed at achieving health equity.
- *Health promotion and education:* Public health initiatives educate urban populations about healthy behaviors, disease prevention, and the importance of regular medical check-ups. These programs can reduce the burden of both communicable and non-communicable diseases.

Solving Urban Health Problems

Effective urban health strategies require a multifaceted approach:

- *Improving infrastructure:* Enhancing public transportation, sanitation, and housing can reduce the spread of infectious diseases and improve overall quality of life. Better infrastructure can also facilitate physical activity and reduce pollution.
- *Promoting healthy lifestyles:* Urban planning should include green spaces, pedestrian-friendly zones, and facilities that encourage physical activity. Additionally, public health campaigns can promote healthier eating and discourage smoking and excessive drinking.
- *Strengthening health systems:* Urban health services need to be robust, accessible, and capable of handling diverse health needs. This includes better primary healthcare facilities, emergency services, and specialized care for chronic conditions.
- *Environmental interventions:* Reducing air pollution through stricter regulations on emissions, promoting renewable energy, and improving waste management systems can significantly decrease the burden of respiratory diseases.
- *Mental health support:* Increasing awareness, reducing stigma, and providing accessible mental health services are crucial in addressing the mental health crisis in urban areas.
- *Community engagement:* Engaging urban communities in health initiatives ensures that interventions are culturally appropriate and effectively meet the needs of diverse populations.

Conclusion

Urban epidemiology is a vital discipline that informs public health policies and interventions in our increasingly urbanized world. By understanding the unique health challenges that cities face and implementing comprehensive, sustainable strategies, we can create healthier urban environments. The goal is not just to manage diseases but to foster environments where urban populations can thrive, leading to a healthier, more resilient society.

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Risk Factors Associated with an Influenza B Outbreak due to Inefficient Screening in a Prison in Thailand

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Abstract

On 3 Oct 2019, the Office of Disease Prevention and Control Region 12 Songkhla received notification of a suspected influenza cluster in a prison in Songkhla Province, Thailand. In cooperation with the local public health teams, we investigated the event to confirm the diagnosis, identify the source of infection, and implement control measures. A suspected influenza case was defined as an individual with fever and at least one of the following symptoms: cough, sore throat, runny nose, or dyspnea. A confirmed case was a suspected case who tested positive to influenza by the reverse transcription polymerase chain reaction technique. An environmental survey was conducted to assess risk behaviors and determine the occupancy rate. A case-control study was performed to identify associated factors of developing influenza. We identified 128 suspected cases, of which seven were confirmed to have type B influenza. All were male and their median (interquartile range) age was 29 years (24–35). The overall attack rate was 5.2%. The first case developed symptoms in the new prisoner zone and moved to another zone without undergoing respiratory screening. The analytical study revealed that sleeping within one meter of a confirmed case (adjusted odds ratio (AOR) 1.77, 1.07–2.92), and sharing drinking glasses with others (AOR 1.83, 1.18–2.82) were significant risk factors. The overcrowded prison (165% occupancy) led to limited availability of vaccines, causing 83.5% of prisoners to be unvaccinated. Strict screening of new prisoners before moving to another area and early isolation of symptomatic prisoners are recommended.

Keywords: influenza B outbreak, prison, Southern Thailand, screening, isolation

Introduction

Influenza is an infectious disease caused by viral infection. It has caused multiple global pandemics.[1] Three types of influenza viruses—A, B, and C—infect humans with types A and B causing widespread epidemics.[2] The incubation period is about two days, ranging from 1–4 days.[2] Transmission occurs through respiratory droplets when an infected person coughs or sneezes. High-risk areas include crowded places such as schools, factories, and prisons.

In Thailand, overcrowded prisons, or those with high occupancy rates, have an increased risk of influenza outbreaks.[3] According to the Disease Outbreak Surveillance Program, Division of Epidemiology, Ministry of Public Health, prisons were identified as the most prevalent environment (37%) for influenza outbreaks between 2017 and 2019.[4] In 2019, The National Health Security Office of Thailand initiated a flu vaccination program in all prisons, distributing around 125,254 doses. However, only about one in three prisoners received the vaccine.[5] The program targeted seven vulnerable groups: individuals over 65, those with certain chronic diseases, obesity, neurological impairments, thalassemia or compromised immune systems, children aged six months to two years, and pregnant women beyond 34 weeks gestation.[6]

On 3 Dec 2019, the Office of Disease Prevention and Control 12 Songkhla (OPDC 12) received a report of 14 suspected influenza cases among prisoners in a prison in Songkhla Province. From 6 to 11 Dec 2019, an ODPC 12 investigation team, in collaboration with the Provincial and District Public Health Office, conducted an outbreak investigation to confirm the diagnosis, identify the source of the infection, investigate risk factors for the outbreak, provide recommendations, and implement control measures.

Methods

We interviewed prison staff to gather information about the prison's characteristics, annual influenza vaccinations and the process of admitting and transferring new prisoners, particularly the process of screening for respiratory diseases.

An active case finding was conducted among prison staff and prisoners. Prisoners were screened for fever, focusing on those with a body temperature exceeding 38 °C or a recent fever since 2 Nov 2019. Those meeting the criteria were interviewed using a semi-structured questionnaire. Cases were classified based on the World Health Organization (WHO) criteria. Suspected cases included prisoners and prison staff in the prison with fever or body temperature exceeding 38 °C, along with one or more of the following symptoms: cough, sore throat, runny nose, and dyspnea, between 2 Nov and 12 Dec 2019. Confirmed cases were those meeting the suspected case definition and testing positive for the influenza virus via reverse transcriptase polymerase chain reaction technique.

A semi-structured questionnaire was used to gather data, including demographic characteristics (age, gender, dormitory), signs and symptoms, annual influenza vaccination and high-risk behaviors. The high-risk behaviors were divided into four parts: 1) contact history with case, such as sleeping near (less than one meter) a case, eating at the same table with a case, and having close contact (less than one meter) with a case; and 2) sharing personal belonging with other prisoners (e.g., clothes and towels, spoons, drinking glasses and phone at the visiting room); 3) personal hygiene (washing hand with soap after using toilets; and 4) history of receiving the annual influenza vaccine.

We purposively sampled 10% of the suspected cases with illness onset less than five days prior to the day of investigation. Throat swab samples were collected and sent to the OPDC 12 laboratory center, where they were tested for influenza.

An environmental study was conducted to inspect various prison zones, including handwashing stations, screening points, isolation rooms, dining areas, dormitories, vocational training areas, and guest visitation rooms. We assessed dormitory density by calculating the area per prisoner and the occupancy rate by dividing the current number of all prisoners by the prison's capacity.[7]

We conducted an unmatched case-control study to investigate factors associated with being a case. The case group included all suspected and confirmed influenza cases, while the control group consisted of asymptomatic prisoners during the same period. We excluded those with suspected influenza symptoms or influenza diagnoses two weeks before the outbreak period. Convenience sampling was used to select the control group at a 4:1 ratio. All selected participants were interviewed. The sample size was determined using an unmatched case-control formula with a significance level of 0.05 and a power of 0.85.[8] The estimated influenza proportion among those with long-time exposure to the ward in the prison and among those without was 71% and 44%, respectively.[9] This resulted in 37 case group participants and 148 control group participants.

Statistical Analysis

Descriptive statistics for continuous data included median and interquartile range (IQR), while categorical data were presented as frequency and proportion. Analytic statistics involved univariable and multivariable logistic regression to determine factors associated with being a case. We calculated odds ratio (OR) and 95% confidence intervals (CI). Variables with a *p*-value <0.1 in univariable analyses and the influenza vaccine variable (due to strong evidence in preventing infection) were included in the multivariable model.[10] Adjusted OR with 95% CI were reported. Microsoft Excel 2016 and R version 4.2.1 were used for data processing.[11,12] Significant factors from the model were used to calculate the population attributable fraction (AF_p) to determine the proportional reduction in disease if exposure to a risk factor was eliminated using the following modified formula:[13]

$$AF_p = \frac{P_c(OR - 1)}{OR}$$

where P_c is the exposure prevalence among case.

Ethics

Ethical clearance was omitted as this investigation was conducted in response to a disease outbreak. Interviewees were informed about the benefits and objectives before interviews. Responses were documented without recording names or addresses. Completed questionnaires were securely stored, with access limited to the principal investigator who will responsibly dispose of the data after publication.

Results

Descriptive Study

At the time of the investigation, the prison contained 2,844 prisoners (2,497 males and 347 females) and 78 prison staff. Around 83.5% (2,041/2,443) of prisoners were unvaccinated against influenza in 2019 due to limited vaccine supply caused by overpopulation. The prisoners were divided into five zones. Zones 1 and 2 contained general male prisoners. Zone 1 had one dormitory and Zone 2 had four dormitories with an area for vocational training. Zone 3 was designated for new male prisoners and had three dormitories. New prisoners usually received a two-week orientation course, which included an introduction to prison rules to help them adjust to their new environment. Prison health officials typically screened for underlying diseases, conducted urine drug tests, assessed mental health, and checked for recent respiratory symptoms to prevent outside infections to enter the prison. Usually, new prisoners without symptoms participated in routine activities, such as waking up at a certain time, exercising, eating meals in the canteen, participating in recreational activities, attending orientation sessions, and sleeping in dormitories. Prisoners with fever or respiratory symptoms were isolated until recovery before rejoining others or moving to another zone. Occasionally, when a large number of prisoners entered simultaneously and overwhelmed Zone 3, prison staff placed both symptomatic and asymptomatic prisoners in the same dormitory necessitating swift relocation to other zones, which could compromise the effectiveness of disease screening and isolation efforts. Zone 4 consisted of a medical clinic and had no dormitory. Zone 5, reserved for female prisoners, had one dormitory and was physically separated from the other zones in terms of location, activities, and prison staff.

On 11 Nov 2019, 29 prisoners were relocated from dormitories 2 and 3 of Zone 3 to different dormitories in Zone 2, including the first case, who entered the prison on 6 November and developed symptoms on 10 November, along with two others presenting with respiratory symptoms on 11 November. These prisoners were not screened or isolated and stayed in Zone 3 for less than one week due to overcrowding. Consequently, symptomatic prisoners from Zone 3 were placed with asymptomatic prisoners in Zone 2. Approximately two weeks later, on 29 November, medical staff identified a suspected cluster of influenza cases in Zone 2 due to a surge in cases visiting the clinic.

From the active case finding, we identified 128 cases, of which 7 (5.5%) were confirmed. All cases were male, with an attack rate of 5.2% among male prisoners (128/2,443), and no deaths. No cases were reported among prison staff. The median (IQR) age of the cases was 29 years (24–35). All had fever with other common symptoms including cough (81.9%), runny nose (65.7%), sore throat (58.1%), and dyspnea (17.1%). Oseltamivir, an antiviral drug, was administered to 35 cases (27.3%) with severe symptoms, such as high-grade fever, severe cough, and dyspnea. Most (96.9%) did not belong to any vulnerable group. Four cases belonged to vulnerable group: two were obese, one had chronic obstructive pulmonary disease, and one had compromised immunity. There were no reported complications or referrals.

The first case developed symptoms on 10 November, and the last case on 12 December, with the peak on 2 Dec 2019 (Figure 1). The attack rates in zones 1, 2, 3, and 4 were 0.1%, 7.3%, 11.7% and 5.5%, respectively (Table 1). Zone 3, used for new arrivals, had the highest attack rates, especially in dormitories 2 and 3, at 22.9% and 27.8%, respectively. In Zone 2, dormitories 1, 2, 3, and 4 had attack rates of 9.8%, 8.2%, 3.7%, and 4.0% respectively.

The survey of cases identified high-risk behaviors as sharing drinking glasses (62.4%), using phones in the visiting room (51.5%), sleeping within one meter of a case (41.6%), close contact (within one meter) with a case (38.6%), eating at the table with a case (20.8%), sharing spoons (13.9%), sharing clothes or towels (12.9%).

Table 1. Number of influenza cases and area density by dormitory, 2 Nov–12 Dec 2019, in a prison in Songkhla Province, Thailand

Prison zone	Total population screened	Number of cases	Attack rate (%)	Area density (m^2 /prisoner)
Zone 1 (General prisoner zone)				
Dormitory 1	890	1	0.1	0.6
Zone 2 (General prisoner zone)	**1,238**	**90**	**7.3**	-
Dormitory 1	435	43	9.8	0.6
Dormitory 2	365	30	8.2	0.6
Dormitory 3	217	8	3.7	0.9
Dormitory 4	221	9	4.0	0.9
Zone 3 (New prisoner zone)	**315**	**37**	**11.7**	-
Dormitory 1	208	21	10.1	0.7
Dormitory 2	35	8	22.9	0.6
Dormitory 3	18	5	27.8	1.2
Zone 4 (Healthcare zone)	**54**	**3**	**5.5**	-

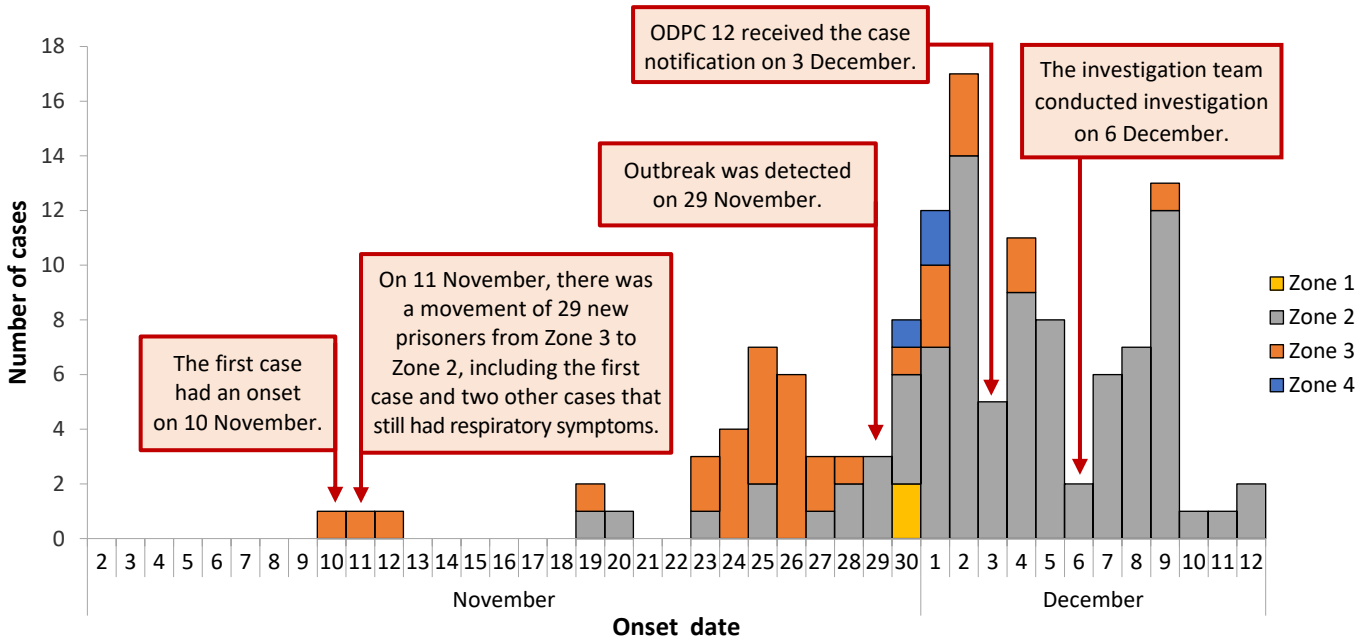

Figure 1. Number of influenza cases by onset date, 2 Nov–12 Dec 2019, in a prison in Songkhla Province, Thailand (n=128)

Laboratory Study

Nine of the 128 suspected cases (7.0%) had throat swabs performed, of which seven tested positives for influenza type B virus (lineage or clades were not reported). Influenza types A and C virus were not detected.

Environmental Study

The average area density of all dormitories was 0.8 m^2/prisoner and the prison occupancy rate was 165% (2,844/1,720). In all dormitories, there were fans for ventilation, but the air circulation was insufficient, resulting in musty odors and damp surroundings. Handwashing stations and soap were available, but infrequently used. The phones in visiting room were not disinfected after each use. The dining area provided utensil and individual trays.

Analytic Study

The analyzed group consisted of 587 individuals, including 128 cases and 459 controls. The multiple logistic regression analysis revealed that sleeping near case (OR 1.77, 95% CI 1.07–2.92) and sharing drinking glasses (OR 1.83, 95% CI 1.18–2.82) were statistically significant associated with influenza infection. The population attributable fraction (AF_p) for these factors were 16.3% and 29.8%, respectively.

Table 2. Factors associated with an influenza B outbreak, 2 Nov–12 Dec 2019, in a prison in Songkhla Province, Thailand

Associated factors	Cases (n=128)	Controls (n=459)	Univariable	Multivariable	
			Crude OR (95% CI)	Adjusted OR	95% CI
Contact history					
Sleeping near a case*	48	95	2.42 (1.54–3.78)†	1.77	1.07–2.92
Eating at the same table with a case	26	44	2.47 (1.40–4.34)†	1.74	0.96–3.15
Close contact with a case*	57	144	2.00 (1.29–3.06)†	1.41	0.87–2.29
Share personal belongings					
Sharing clothes or towels	14	41	1.27 (0.62–2.48)		
Sharing spoons	12	45	0.97 (0.45–1.93)		
Sharing drinking glasses	84	235	1.90 (1.23–2.95)†	1.83	1.18–2.82
Sharing a phone in the visiting room	59	254	0.67 (0.44–1.01)†	0.66	0.44–1.01
Personal hygiene					
Washing hands with soap after using the toilet	44	190	0.75 (0.48–1.1)		
Immunization					
Receiving the annual influenza vaccine	3	13	0.83 (0.15–3.10)	1.15	0.31–4.22

**Within 1 meter. †P-value <0.1. Variance inflation factor <10 for all factors, no multicollinearity. OR: odds ratio. CI: confidence interval.*

Action Taken

We emphasized to the prison's chief executive officer the importance of implementing customized health screening, focusing on respiratory symptoms, particularly in Zone 3, even under crowded condition. Symptomatic individuals should be isolated until their symptoms abate, while asymptomatic prisoners should complete an incubation period of around one week before being transferred to another zone. Oseltamivir was administered to suspected and confirmed cases to reduce the spread of the disease. We distributed additional face masks to prisoners, in addition to what the prison already had, to cover all prisoners, specifically those who were symptomatic, and hand sanitizers to prisoners in all zones, particularly in zones 2 and 3. We urged prisoners to avoid group activities and to refrain from arranging visits from friends or relatives until the outbreak subsides.

Discussion

This investigation identified an influenza B outbreak in a Thai prison with an attack rate of 5.2%. No cases of influenza types A or C were identified. Some prisoners tested negative for all types. Overcrowding was evident in all dormitories. We found statistically significant associations for sleeping near another case and sharing drinking glasses with others. The likely cause of this outbreak was the movement of newly admitted prisoners without effective screening and, for asymptomatic prisoners, an insufficient incubation period. Vaccine supply was insufficient.

The attack rate among prisoners was 5.2%, which was higher than outbreak rates for influenza type B (approximately 0.6%) and type A (approximately 2.3%) in communities reported by a previous meta-regression analysis.[14] Despite the fact that the influenza type B virus strain mutates more slowly compared to type A, it leads to more severe outbreaks in crowded and densely populated places such as schools, military camps, nursing homes, and prisons.[15,16] However, the severity of outbreaks also depends on the presence of high-risk individuals among the cases, as well as their access to treatment with antiviral drugs and prevention through vaccination.[17,18]

Laboratory testing to confirm influenza virus infection for two suspected cases yielded negative results for both influenza types A and B. However, we believe that there was a high likelihood of these two cases having influenza B due to clinically compatible symptoms and epidemiological links with confirmed cases. An inability of the test to confirm the pathogen may have occurred for various reasons, such as inadequate sample collection, improper handling before testing, or testing outside the viral shedding period.[19]

According to the WHO's definition of influenza-like illness, cases should have a fever of 38 °C or higher and present with coughing. However, in the current prison outbreak, where there was overcrowding (165% occupancy) and limited space (dormitory density 0.8 m^2/prisoner—the standard is >3.4 m^2/prisoner), the risk of respiratory diseases spreading quickly was high. To improve the sensitivity of case detection, we modified the WHO's definition. Currently, prisoners are screened if they have a history of fever or a temperature above 38 °C, along with any respiratory symptom, and regardless of cough. This change aimed to increase the screening sensitivity from 20.0% noted in the previous study, which assessed the validity of influenza case definitions.[20]

The source of this outbreak was likely due to the movement of newly admitted prisoners without effective screening. Additionally, there was a risk posed by prisoners who did not exhibit symptoms but could be contagious during the incubation period when they had recently acquired the infection. This continuous transmission could occur if they were not segregated into separate dormitory areas from the beginning of the illness or isolated appropriately before being moved to other zones. Lack of precautionary measures was a major contributing factor to a previous outbreak in Canada.[21]

The significant risk factors contributing to the person-to-person transmission of the disease in this current investigation were delays in segregating infected patients, sleeping within one meter of a case, which showed a with 16.3% reduction in the risk of becoming a case, the high occupancy rate in the prison and the high density of prisoners in the dormitories. These factors align with previous reports on influenza outbreaks in prisons and highlight the importance of promptly isolating infected individuals, following the guidelines recommended by the Infectious Diseases Society of America.[22,23]

Under a limited supply of vaccines from the Thai government, a concerning issue arises in Thailand as nearly half of the country's prisons experienced at least one outbreak during 2017–2019.[4] This issue is compounded by the inherent nature of prisons, which have a higher prevalence of respiratory illnesses and immunosuppression (HIV infection) among prisoners compared to the broader community.[24,25] This poses a high risk as vulnerable people infected with influenza can easily transmit the virus to others due to the close living quarters and constant turnover of people.[26] Thailand should implement a policy to distribute flu vaccines to all prisoners, with a particular focus on covering all vulnerable groups. While this measure

might increase the budget burden, it has the potential to help reduce both the number of infected cases and all related costs, including treatment and disease control expenses.[27]

Due to an insufficient quantity of vaccines and the continuous influx of new prisoners who may be infectious, vaccination alone is not a suitable short-term control measure during an outbreak in prisons. However, previous studies have shown promising results with Oseltamivir, which may be a potential option for reducing the number of influenza cases.[16] However, non-pharmaceutical interventions such as early case detection and isolation, limited movement, and the provision of sanitation and practical advice on disease prevention, remain crucial and must be implemented alongside other interventions.[18]

Limitations

Restricted by limited vaccination data for individuals and frequent prisoner movement, especially those without symptoms, we were unable to calculate the vaccine effectiveness. Furthermore, due to safety concerns, prison guards could not directly escort us to all dormitories, limiting our exploration of environmental sanitation behaviors through direct observation. Therefore, we conducted interviews with prison staff and prisoner health volunteers. Due to time constraints, we employed convenience sampling for controls, potentially introducing selection bias. To mitigate this, prison staff called upon control groups primarily from zones 2 and 3 across various dormitories where numerous cases occurred, assuming similar exposure to minimize bias. It should be acknowledged that while controls were selected based on the absence of influenza symptoms and recent diagnoses within two weeks prior to the outbreak period, some may have had prior infections beyond this timeframe, potentially affecting their immunity, which could potentially influence our findings.

Conclusion

We confirm an influenza outbreak in a prison in Songkhla Province, Thailand. A total of 128 cases were found, all of which were male prisoners, with no severe cases. The source of the outbreak was suspected to be from outside the prison, due to new prisoners moving from an induction zone to other incarceration zones without screening. All dormitories were overcrowded. Risk factors included close contact with infected cases and sharing drinking glasses. To mitigate the risk of future influenza outbreaks, prisons and local public health authorities should implement rigorous screening procedures for new prisoners. Symptomatic individuals should be promptly isolated until symptom-free, and asymptomatic prisoners should undergo a sufficient incubation period before being transferred to another zone. Prioritizing education on personal hygiene, with an emphasis on discouraging the sharing of personal items, is essential. These measures can effectively prevent the spread of influenza and enhance overall public health within prisons.

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An Investigation of Food Poisoning Outbreak among Meeting Attendees in Pattaya City, Thailand, following Post-pandemic Kitchen Reopening, August 2022

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Abstract

On 9 Aug 2022, meeting attendees at Hotel B in Pattaya City developed gastrointestinal symptoms during a tourism reopening after Thailand had transitioned to the post-COVID-19 phase. We investigated to confirm the diagnosis, describe outbreak characteristics, identify possible sources and risk factors of the outbreak, and provide recommendations. A food poisoning case was an individual staying in Hotel B on 8–9 Aug 2022 and experienced at least one of the following symptoms: diarrhea, nausea, vomiting and abdominal pain. We sent a self-administered questionnaire to all attendees and interviewed the cases. Food preparation and processing were examined. We swabbed kitchenware and food handlers' hands and collected water samples for bacterial culture. We conducted a retrospective cohort study and used Poisson regression with a robust standard error model. Fifty-five percent of the attendees responded to the questionnaire; the attack rate was 34%. Common symptoms were diarrhea (100%) and abdominal pain (80%). The median incubation period was 7–13 hours. Stewed pork leg with kale had the highest adjusted risk ratio of 27.82×10^6 (95% CI 9.06×10^6–85.44×10^6). It was reported as cold with an unusual smell and taste. We found *Bacillus cereus* and *Aeromonas spp.* on kitchenware and in filtered water. The incubation period, symptoms, and laboratory results suggested that *Bacillus cereus* was the most likely pathogen from the stewed pork leg. We recommended sanitizing the kitchen and kitchenware, promoting food sanitary awareness, and ensuring the quality of water supply system, particularly for hotels preparing to reopen after prolonged closure.

Keywords: *Bacillus cereus*, food poisoning, outbreak, Pattaya City, Thailand

Introduction

In 2022, the World Health Organization estimated 600 million foodborne-illness cases, causing 420,000 deaths, and around 33 million years of healthy lives lost due to eating unsafe food worldwide each year.[1] In 2021, Thailand reported approximately 59,000 cases of food poisoning with an attack rate of around 90 cases per 100,000 population, most of the cases aged 15–24 years.[2] Furthermore, Thailand has reported an average of 50 foodborne outbreaks annually.[3]

Coronavirus disease 2019 (COVID-19) pandemic impacted tourism worldwide.[4] The Thai government restricted international tourists and domestic travel causing numerous hotels to experience financial setbacks and closures.[5,6] In Pattaya City, a vibrant tourist destination located on Thailand's eastern Gulf coast, 10%–50% of hotels experienced temporary closures for up to three months.[7]

As of 1 Jul 2022, Thailand entered the post-pandemic phase of COVID-19, allowing tourism to gradually

reopen.[8,9] On 10 Aug 2022, the Division of Epidemiology received a notification concerning a cluster of food poisoning cases related to a meeting of attendees from a medical school, held at Hotel B during 8–9 Aug 2022, in Pattaya City. Subsequently, an investigation was conducted by the Division of Epidemiology staff and local health staff on 10–11 Aug 2022 to confirm the diagnosis, describe outbreak characteristics, identify the possible source and risk factor of the outbreak, and provide recommendations for prevention.

Methods

Epidemiologic Investigation

We defined a food poisoning case as an individual staying in Hotel B on 8–9 Aug 2022 and experiencing at least one of the following symptoms: diarrhea, nausea, vomiting, and abdominal pain. We conducted active case finding among hotel staff and guests who were not meeting participants by interviewing the hotel staff to identify any food poisoning cases. For the meeting participants, we distributed online self-administered questionnaires through the medical school focal point, to gather information of meeting attendees including demographic characteristics, clinical information, and consumed food items between 8–9 Aug 2022. We additionally interviewed 20% of the cases using the convenience sampling method to gather information regarding their illness, treatment, and the suspected food associated with the food poisoning.

Subsequently, a retrospective cohort study was conducted to identify the possible source of the outbreak among the meeting attendees who responded to our questionnaires. Sample size estimation utilized data from a previous study of a food poisoning outbreak associated with eating stewed pork balls, similar to the stewed pork leg, which was suspected to be the source of this outbreak (detailed in the Results section).[10] To achieve 80% power with a 95% confidence interval (CI), the study required 15 participants each in the exposed and unexposed cohorts.

Environmental and Laboratory Studies

We inspected the kitchen environment and the water supply system and interviewed hotel staff and food handlers regarding raw material preparation, cooking processes, and food handling procedures. We collected samples including swabs from kitchen and kitchenware, food handler's hands, and water samples. We tested the samples for coliform bacteria with an SI-2 test kit of the Department of Health. The SI-2 is a peptone-lactose-bromocresol solution used to detect coliform bacteria. It works by detecting gas production and acidification caused by lactose fermentation.[11] Then we sent the samples to the Regional Medical Sciences Center 6 Chonburi for bacteria cultures. We additionally collected water samples for free residual chlorine levels with an O-31 test kit of the Department of Health.[12] It is an orthotolidine-arsenite solution, which reacts with free residual chlorine in a water-sample.[13] Furthermore, we interviewed staff of the Division of Public Health and Environment, Pattaya City about policies and practices governing food sanitary activities in Pattaya City.

Statistical Analysis

We conducted a descriptive study and calculated percentages, median and interquartile range (IQR). For the retrospective cohort study, risk ratio (RR) calculation was performed for each food item using Poisson regression with robust standard error model. Instead of using logistic regression, we used the Poisson regression due to its ability to provide adjusted risk ratio which is more understandable given that the disease was not rare among the affected population in this event. Multivariable analysis was conducted using Poisson regression with robust standard error model to calculate an adjusted RR, focusing on food items served in the most suspected meal, with p-value ≤ 0.1 from univariable analysis. Statistical significance was defined as a p-value ≤ 0.05. Statistical analysis was conducted using R version 4.2.1, with the tidyverse 1.3.1.[14]

Ethics

Since this study was a part of a routine outbreak investigation, ethics approval was not required.

Results

Background of the Event

The meeting of Medical School A included a diverse group of 80 health professionals including executives, instructors, and support staff. The meeting was held at Hotel B on 8–9 Aug 2022, after the official post-pandemic reopening of Thailand's tourism sector. Despite Hotel B remaining operational throughout the pandemic, one of its two kitchens (Kitchen A) underwent a temporary closure between April and June 2022.

Outbreak Description

One day before the meeting, none of the participants experienced any food poisoning symptoms. They had breakfast independently before arriving at Hotel B on the morning of 8 Aug 2022. Kitchen A exclusively catered for the meeting with 23 food items including two main buffet meals (lunch and dinner) on 8 August, as well as three snack breaks—two on 8 August, and one on 9 August.

No food poisoning cases were identified among hotel staff or guests who were not meeting participants. Among meeting participants, the response rate to our questionnaire was 55.0% (44/80). The median age of responder was 47.5 years (IQR 41.0–55.0). Of these, we identified 15 cases corresponding to an attack rate of 34.1% (15/44). The male-to-female ratio was 1:1.5 and the median age was 46.0 years (IQR 41.5–54.0). All cases (15/15) had diarrhea on average three times. Abdominal pain was reported by 80.0% (12/15) of cases, while 6.7% (1/15) experienced nausea and fever; none involved vomiting. All cases exhibited mild symptoms, used self-medication for symptomatic treatment and recovered quickly without seeking medical assistance.

The first case started at 9:00 PM on 8 August, marking the onset of a rising trend that peaked at 1:00 AM on 9 August. Subsequently, the number of cases declined, with the last case recorded at 5:30 AM on 10 August. The epidemic curve indicated a point common source outbreak with a median incubation period around 7–13 hours (Figure 1).

The most common food items among cases at lunch were stewed pork leg with kale (93.3%; 14/15), Tomyum kung (Thai spicy shrimp soup) (86.7%; 13/15), and green curry with chicken (73.3%; 11/15), with a median exposure-to-onset period of 13.0 hours. For dinner, the common items among cases were shrimp dip and vegetables, spicy pork salad, and spicy pork soup (66.7%; 10/15), with a median exposure-to-onset period of 7.0–8.5 hours (Table 1). Around sixty-seven percent (66.7%; 10/15) of the cases reported that the stewed pork leg with kale was perceived as cold, and had an unusual smell and taste, leading them to suspect this item as the potential source of the outbreak.

Table 1. The number of food poisoning cases who consumed each food item and median exposure-to-onset period of food items served in the meeting at Hotel B, Pattaya City, Thailand, 8–9 Aug 2022 (n=15)

Food items	Number of food poisoning cases consumed n (%)	Median exposure-to-onset period (hours)
Lunch		
Stewed pork leg with kale	14 (93.3)	13.0
Tomyum kung	13 (86.7)	13.0
Green curry with chicken	11 (73.3)	13.0
Stir-fried vegetables with oyster sauce	11 (73.3)	13.3
Fish cake	8 (53.3)	12.5
Papaya salad	7 (46.7)	14.5
Stir-fried pork with red curry	7 (46.7)	10.0
Dinner		
Shrimp dip and vegetables	10 (66.7)	7.0
Spicy pork salad	10 (66.7)	8.5
Spicy pork soup	10 (66.7)	7.0
Stir-fried broccoli with oyster sauce	9 (60.0)	7.0
Roasted duck with red curry	8 (53.3)	4.0
Stir-fried beef with black pepper	5 (33.3)	4.0
Stir-fried chicken with red curry	1 (6.7)	4.0
Snack and sweets		
Chicken satay	11 (73.3)	-8.5
Fruit	9 (60.0)	13.3
Fruit tart	9 (60.0)	-9.0
Shrimp dumplings	9 (60.0)	-9.0
Sweet water chestnuts	7 (46.7)	8.0
Tiramisu	7 (46.7)	7.0
Salmon quiche	6 (40.0)	12.5
Opera cake	5 (33.3)	-7.4
White chocolate eclair	4 (26.7)	-7.4

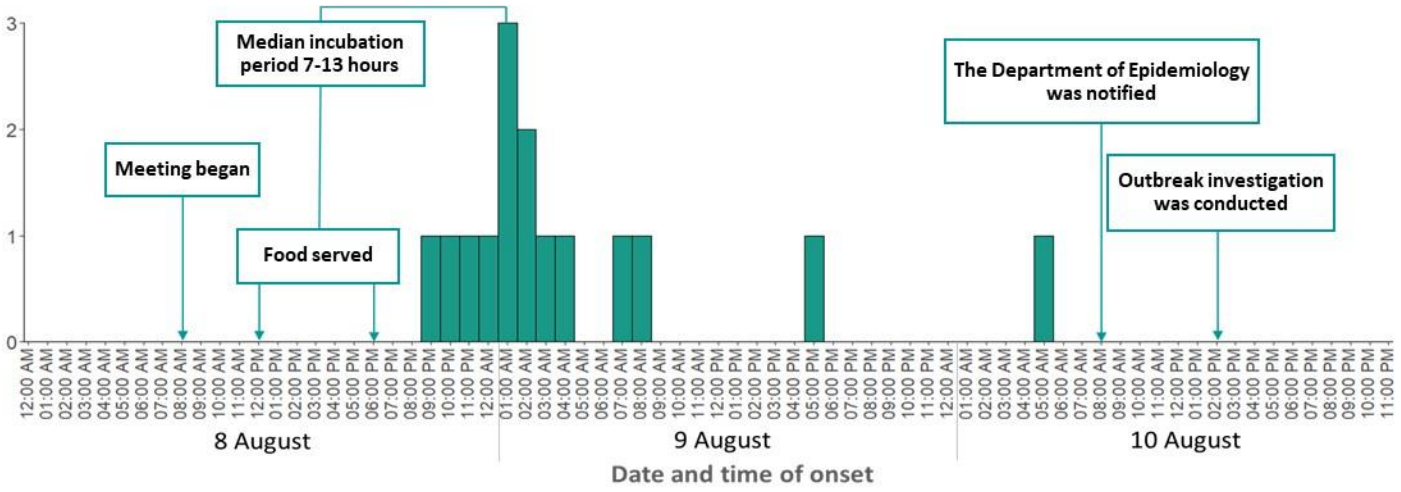

Figure 1. Number of food poisoning cases by date and time of onset in the meeting at Hotel B, Pattaya City, Thailand, 8–9 Aug 2022 (n=15)

Analytical Study Results

The univariable analysis indicated that stewed pork leg with kale served at lunch had the highest crude RR that was statistically significant (crude RR $34x10^6$, 95% CI $10x10^6$–$117x10^6$), followed by green curry with chicken served at lunch (crude RR 3.67, 95% CI 1.16–11.60), and shrimp dip and vegetables served at dinner (crude RR 2.53, 95% CI 1.02–6.28) (Table 2). Both the stewed pork leg with kale and the green curry with chicken were chosen for multivariable analysis. The stewed pork leg with kale had a statistically significant adjusted RR ($27.82x10^6$, 95% CI $9.06x10^6$–$85.44x10^6$), while green curry with chicken showed an adjusted RR of 2.96 (95% CI 0.94–9.32).

Table 2. Risk of being a food poisoning case by foods served in the meeting at Hotel B, Pattaya City, Thailand, 8–11 Aug 2022 (n=44)

Food items	Exposed Attack rate (case/total)	Non-exposed Attack rate (case/total)	Crude RR	95% CI	*P*-value
Lunch					
Stewed pork leg with kale	0.39 (14/36)	0.00 (0/5)	$34x10^6$*	$10x10^6$–$117x10^6$	<0.01
Green curry with chicken	0.52 (11/21)	0.14 (3/21)	3.67*	1.16–11.60	0.03
Tomyum kung	0.42 (13/31)	0.15 (2/13)	2.73	0.69–10.75	0.15
Stir-fried vegetables with oyster sauce	0.41 (11/27)	0.21 (3/14)	1.90	0.62–5.88	0.27
Stir-fried pork with red curry	0.33 (7/21)	0.35 (7/20)	0.95	0.40–2.28	0.91
Papaya salad	0.29 (7/24)	0.42 (8/19)	0.69	0.30–1.60	0.39
Fish cake	0.26 (8/31)	0.50 (6/12)	0.52	0.22–1.20	0.12
Dinner					
Shrimp dip and vegetables	0.53 (10/19)	0.21 (5/24)	2.53*	1.02–6.28	0.05
Stir-fried broccoli with oyster sauce	0.36 (9/25)	0.20 (3/15)	1.80	0.56–5.79	0.32
Spicy pork soup	0.43 (10/23)	0.25 (5/20)	1.25	0.47–3.36	0.66
Spicy pork salad	0.36 (10/28)	0.29 (4/14)	1.74	0.70–4.33	0.23
Stir-fried beef with black pepper	0.38 (5/13)	0.32 (9/28)	1.20	0.49–2.93	0.69
Roasted duck with red curry	0.35 (8/23)	0.33 (7/21)	1.04	0.45–2.43	0.92
Stir-fried chicken with red curry	0.20 (1/5)	0.30 (10/33)	0.66	0.10–4.32	0.67
Snacks and sweets					
Fruit	0.41 (9/22)	0.21 (4/19)	1.94	0.69–5.45	0.21
Salmon quiche	0.50 (6/12)	0.30 (9/30)	1.67	0.74–3.73	0.21
Chicken satay	0.28 (11/40)	0.29 (4/14)	1.28	0.48–3.40	0.62
Tiramisu	0.39 (7/18)	0.32 (8/25)	1.22	0.53–2.80	0.65
Shrimp dumplings	0.36 (9/25)	0.32 (6/19)	1.14	0.48–2.70	0.77
Fruit tart	0.35 (9/26)	0.33 (6/18)	1.04	0.44–2.45	0.93
Opera cake	0.36 (5/14)	0.38 (9/24)	0.95	0.39–2.33	0.92
Sweet water chestnuts	0.29 (7/24)	0.37 (7/19)	0.79	0.33–1.91	0.60
White chocolate eclair	0.25 (4/16)	0.39 (11/28)	0.64	0.24–1.71	0.37

*RR: risk ratio. CI: confidence interval. *P ≤0.05.*

Environmental Survey Result

Hotel kitchen information

The hotel kitchens were certified by hazard analysis and critical control points, and clean food good taste standards ensuring a stringent standard of food hygiene in Thailand. Kitchen A was divided into zones with individual bins, including a meat room, salad room, kitchen zone, and bakery zone. A team of 4–5 staff were assigned to work solely within their zone, prohibiting unauthorized access. The kitchen's environment was carefully maintained, and its surroundings and tools were observed to be clean. We observed separate tools for handling raw materials from those used for cooking, and the kitchen floor remained dry. All cooking surfaces were elevated on a 100-centimeter platform. Every kitchen staff underwent an annual health checkup in October 2021,

with normal results. They were supposed to participate in the annual food sanitary training program from the Division of Public Health and Environment, but it had been interrupted since 2020 due to the COVID-19 pandemic. All kitchen staff on the meeting date wore proper protective equipment and were healthy.

Food preparation process

Menu options were planned two days before the meeting to facilitate raw material preparation and staffing requirements. The raw materials were delivered from familiar suppliers to the hotel one day before the meeting and stored separately in a temperature-controlled stockroom.

The lunch menu preparation started at 7:00 AM, with raw materials such as meat, eggs, and vegetables being retrieved from stock and undergoing a quality check before being prepared. Soup or boiled dishes were cooked at 10:00 AM and kept warm, while fried or stir-fried dishes were cooked at 11:00 AM. Each menu item was taste-tested and wrapped individually before being served at noon.

The dinner preparation started with rinsing and chopping raw materials at 2:00 PM. Soup and boiled dishes were cooked at 4:00 PM and kept warm, while fried or stir-fried dishes were cooked at 5:00 PM. Each menu item was taste-tested, wrapped, and served at 6:00 PM. Any remaining food was discarded four hours after mealtimes. Hotel guests and staff were not allowed to take the leftover food outside the dining area.

However, the stewed pork leg with kale was prepared in the evening before the event. The pork leg was frozen separately from other raw materials, while the stewed soup was stored in a pot and kept warm overnight. All components were reheated together at 10:00 AM on 8 Aug 2022 and served at noon. Although there was no temperature monitor in the reheating step, food handlers reported that it had been boiled.

The water used in food preparation originated from tap water, which was then filtered through the hotel's filtration system. The filtration system was certified annually for biochemical standards by an external company. During the investigation, the free residual chlorine levels were 0.2 ppm in both the consumed water and the tap water. For safety, water for drinking was purchased in bottles, and ice was procured from a certified local ice factory.

Laboratory result

Of the tested kitchen environment surfaces, kitchenware, and food handler's hands samples, 33.3% (4/12) tested positive for coliforms. In the culture tests for enteropathogenic bacteria, 25.0% (3/12) exhibited positive results for *Bacillus cereus,* while 33.3% (4/12) tested positive for *Aeromonas spp.* (Table 3).

Table 3. Coliform test and enteropathogenic bacterial culture results from the Hotel B kitchen, Pattaya City, Thailand, 10 Aug 2022

Group	Specimens	Coliform test	Enteropathogenic bacterial culture
Staff	1st cook's hand	Negative	Negative
	2nd cook's hand	Negative	Negative
	Butcher's hand x2	Negative	***B. cereus***
Kitchen utensil	Knife and cutting board	**Positive**	***B. cereus***
Meat storage room utensils	Tray	Negative	***Aeromonas spp.***
	Gloves	Negative	Negative
	Scale	Negative	Negative
	Grinder	Negative	NA
	Table	Negative	NA
	Knife	**Positive**	NA
Salad preparation room utensils	Tray	**Positive**	***Aeromonas spp.***
	Knife and cutting board	**Positive**	***Aeromonas spp.***
Water	Filtered water	NA	***B. cereus, Aeromonas spp.***
	Tap water	NA	Negative
	Ice	NA	Negative

NA: not available.

Action Taken

We monitored the outbreak situation, and no additional cases of food poisoning in this hotel were reported. Health education session was conducted for hotel staff to raise awareness about pathogens and preventive measures against contamination. We encouraged the staff to promptly clean the kitchen and assess potential routes of contamination. Additionally, we advised the hotel to improve the quality of the water supply system.

Discussion

We confirmed the food poisoning outbreak among meeting attendees. This was the first documented food poisoning outbreak related to a kitchen reopening after the COVID-19 pandemic in Thailand. The findings suggested environmental contamination in this kitchen, and the stewed pork leg was the most suspected source. Although a confirmed diagnosis could not be established due to the lack of stool samples from the cases, laboratory results from environmental specimens indicated *B. cereus* and/or *Aeromonas spp.* might be the pathogen of this outbreak. Coinfection of *B. cereus* and *Aeromonas spp.* has previously been identified as an occasional cause of food poisoning outbreaks in Thailand. In a previous food poisoning outbreak investigation in 2020, both *B. cereus* and *Aeromonas spp.* were identified as pathogens, with similar symptoms of diarrhea and abdominal pain among cases, and a similar overall attack rate to our outbreak.[15] *B. cereus* can lead to two types of food poisoning: emetic and diarrheal syndromes depending on the type of food. The emetic type is associated with consumption of starchy foods such as rice and pasta, whereas the diarrhea type is associated with protein-rich foods such as meat and milk. *B. cereus* diarrhea typically presents with mild symptoms, afebrile, and self-limited within 24 hours. The incubation periods for the emetic and diarrheal types are 0.5–6 hours and 8–16 hours, respectively.[14,17] Food poisoning caused by *Aeromonas spp.* typically presents with watery diarrhea and occasionally persistent for a few days. About 50% of cases also experience fever and abdominal cramps, while nausea and vomiting are less common. The incubation period for Aeromonas food poisoning is 1–2 days.[18–20]

The epidemic curve of this outbreak suggested a median incubation period of 7–13 hours, consistent with *B. cereus* diarrhea syndrome rather than Aeromonas infection. Moreover, the clinical presentation, marked by predominant symptoms of diarrhea, a low incidence of fever, and the severity and duration of illness, closely resembled the characteristics of *B. cereus* diarrheal syndrome. Although coinfection with these two bacteria was possible, the collective evidence suggested that *B. cereus* was likely the major causative pathogen of this outbreak, affecting a larger portion of cases compared to *Aeromonas spp.*

In this outbreak, the stewed pork leg with kale was most likely the source. Despite being initially cooked, the overnight storage posed a potential risk of contamination, enabling the multiplication of pathogens. The reported characteristics of the stewed pork leg by cases, included cold temperature, and unusual taste and smell, which suggested inadequate reheating temperature. This leads to an additional hypothesis that contamination can also occur during the reheating, possibly originating from water used for deconcentrating the soup. Furthermore, the highest risk ratio supports the likelihood that the stewed pork leg with kale was the source of the outbreak. Several other food items in this outbreak showed a potential risk of food poisoning, possibly attributed to cross-contamination during the food preparation.[16,18]

The positive coliform test, coupled with positive bacterial culture from filtered water, and kitchenware, suggested potential cross-contamination, which might have occurred initially from filtered water to kitchenware, and finally to foods during various preparation steps. When reopening after a prolonged closure, restaurants should ensure the readiness of the water supply system. This includes regularly draining water during periods of closure to prevent bacterial growth in stagnant water, contacting the local water utility to inquire about recent water supply disruptions, and checking water disinfectant residuals, ensuring that all maintenance activities meet water standards regulation.[21,22] The COVID-19 pandemic significantly disrupted Thailand's tourism. This kitchen was temporarily closed from April to June 2022. At the same time, the annual food sanitary training program was suspended. These factors might have contributed to a decline in food safety awareness among staff, who overlooked certain food preparation processes e.g., reheating.

Limitations

We encountered several limitations. First, the low response rate and limited number of interviews might introduce selection bias. However, we attempted to mitigate this by urging attendees to respond to questionnaires and participate in interviews through the department leaders. Secondly, during interviews with kitchen staff, the presence of the hotel manager and head chef might introduce information bias regarding the food preparation process. To minimize this, we conducted individual interviews with kitchen staff, hotel manager, and head chef. Thirdly, as all cases were health professionals with mild symptoms who recovered quickly, we were unable to collect any stool samples to confirm the pathogen. Fourthly, the hotel's policy, which mandates the disposal of leftover food within four hours after the meal, hindered the collection of food samples. As a result, we lacked direct evidence of a pathogen from both cases and the

suspected food, casting caution on the interpretation of the suspected pathogen. Lastly, the limited number of variables to fit in the multivariable model resulted in a failure to demonstrate adjusted RR of food items. Nevertheless, the study findings were sufficient to identify the risk factors contributing to the outbreak and highlight areas for improving sanitation.

Recommendations

To prevent food poisoning, we recommend eating newly cooked food. To prevent *B. cereus* contamination, Hotel B should ensure that food is cooked and reheated at an appropriate temperature of >74 °C for at least 15 seconds, and that kitchenware is regularly washed.[17] Hotel B should identify and rectify routes of environmental and water supply contamination promptly. Moreover, hotels planning to reopen after a prolonged closure must prioritize checking the quality of the water supply systems to ensure a safe transition. Lastly, the Division of Public Health and Environment Pattaya City should resume the annual food hygiene training that was interrupted by the COVID-19 pandemic, to enhance sanitary awareness among food handlers.

Conclusion

The food poisoning outbreak occurred at Hotel B, Pattaya City, Thailand, in August 2022, during Thailand's post-COVID-19 tourism reopening. The stewed pork leg with kale was suspected to be the food source. The most likely pathogen was *Bacillus cereus*. Contamination might have occurred initially from filtered water to kitchenware, and finally to foods during various preparation steps. However, confirmation was hindered by lack of relevant samples from both the served foods and affected cases. Recommendations focus on improving food sanitation practices including thorough kitchenware cleaning, identifying, and addressing potential sources of contamination, promoting sanitary awareness among staff, and checking the water supply system quality following prolonged closure.

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An Investigation of Ciprofloxacin-resistant *Neisseria Meningitidis* Serogroup B Infection Outbreak in a Provincial Prison, Nan Province, Thailand, October 2023

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Abstract

Meningococcal infection is a severe illness that can result in organ damage or death. On 23 Oct 2023, a joint investigation team was notified about two inmates diagnosed with meningococcal infection in a provincial prison. The investigation aimed to confirm the outbreak, describe epidemiological characteristics, determine possible source and risks of infection, and provide recommendations and control measures. This study reviewed the situation using surveillance databases. Active case finding was conducted among inmates and prison staff. Close contacts were identified and assessed. Drug sensitivity and serogroup identification were done in the cultured-growth specimens. Surveying inmate rooms, observing inmates' behaviors, and interviewing inmates and prison staff were performed. There were 7 laboratory-confirmed cases identified (attack rate 0.5%). All cases were male inmates with a median age of 46 years (interquartile range 38.5–49.5 years). Common symptoms were fever (100%) and headache (71%). Eight cases required hospital admission and one dead case was found (CFR 14%). Among 609 close contacts, 99% were inmates. All cultured-growth specimens were *Neisseria meningitidis* serogroup B with ciprofloxacin resistance. Crowded inmates and sharing water cups were risk factors for intra-room spreading. Daily activities and the previous influenza outbreak promoted inmates' inter-room contact. This is the ciprofloxacin-resistant serogroup B meningococcal disease outbreak in a provincial prison revealing multiple factors, including environmental, behaviors and daily activities, that promoted the disease's spread. Rifampicin chemoprophylaxis, active surveillance, and limited inmate activities could help reduce disease spread.

Keywords: meningococcal, meningitis, *Neisseria meningitidis*, prison, serogroup B, ciprofloxacin resistance, outbreak, Thailand

Introduction

Meningococcal disease is caused by *Neisseria meningitidis (N. meningitidis)*. It has 13 serogroups with the invasive serogroups being A, B, C, W-135, X, and Y.[1] It spreads through droplets or close contact with an infected person.[2] The incubation period ranges from 2 to 10 days. Symptoms include fever, loss of consciousness, vomiting, headache, stiff neck, and purpura fulminans.[3] Even with early diagnosis and treatment, case fatality rates can range from 8 to 15 percent.[4] The prevalence of asymptomatic carriers can vary from 1 to 30 percent.[5]

N. meningitidis stands as a leading cause of meningitis and rapidly fatal sepsis worldwide. Annually, more than 430,000 meningococcal cases and 32,000 deaths were reported.[6] Thailand has reported sporadic cases of meningococcal disease throughout the year with 1–3 confirmed cases per event.[7] The major serogroup in Thailand is serogroup B.[8,9]

To prevent secondary meningococcal disease infection, chemoprophylaxis, involving ciprofloxacin, rifampicin, ceftriaxone, or azithromycin, is recommended for high-risk close contacts.[10] Ciprofloxacin is the commonly used first-line chemoprophylaxis medication in Thailand due to its ease of single-dose oral administration. However, a ciprofloxacin-resistant strain of *N. meningitidis* has been reported globally and these resistant strains are present in all serogroups.[11–14] The emergence of the resistant strains raises concerns about current recommendations.

On 23 Oct 2023, the Division of Epidemiology, Department of Disease Control was notified about two confirmed meningococcal septicemia patients from Nan Provincial Public Health Office. Both were inmates from a provincial prison. The Department of Epidemiology investigated to confirm the outbreak, describe the epidemiological characteristics, determine possible sources and risks of infection, and provide recommendations and control measures.

Methods

Descriptive Study

To confirm an outbreak and assess the magnitude of meningococcal disease, this study reviewed the situation of meningococcal disease in Nan Province between 1 Jan 2018 and 30 Sep 2023. This study extracted data on reported meningococcal disease patients from the National Disease Surveillance database, Event-based Surveillance, and Health Data Center database (ICD-10 codes "A390"–"A399"). This study also interviewed the laboratory technician at Nan Hospital regarding *N. meningitidis* detection.

This study conducted a descriptive study including active case finding among inmates and staff in a provincial prison. A suspected case was defined as an inmate or staff in a provincial prison who had a history of fever or body temperature >38 °C, along with at least two of the following symptoms: stiff neck, alteration of consciousness, seizure, headache, vomiting, dyspnea, and purpura fulminans between September and November 2023. A confirmed case was a suspected case that tested positive for *N. meningitidis* through at least one of the following tests: blood culture, cerebrospinal fluid (CSF) culture, serum reverse transcriptase polymerase chain reaction (RT-PCR), or CSF RT-PCR. This study conducted active case finding on 27 Oct 2023 by announcing anyone who had a fever or body temperature ≥37.5 °C would be interviewed using a semi-structured questionnaire. In addition, this study interviewed cases who received medical services at Nan Hospital and reviewed their medical records. Collected variables were age, gender, underlying disease, inmate room, onset, signs and symptoms, laboratory results, and history of contacts in the past 10 days before symptom onset.

Close contact tracing was conducted to avoid future occurrences by interviewing confirmed cases, prison staff, and nurses at Nan Hospital. Close contact was defined as an inmate living in the same room as the confirmed case or a person who had a history of close contact (caring, talking, working, eating, kissing, hugging, or sharing eating utensils) with a confirmed case without proper protection between 10 days before symptom onset of the confirmed case and one day after the confirmed case received an appropriate antibiotic.

Laboratory Study

This study reviewed blood culture, CSF culture, serum RT-PCR, and CSF RT-PCR results of inmates diagnosed with meningococcal disease. This study collected blood specimens from a suspected case who still exhibited symptoms on the investigation day (27 Oct 2023) for blood culture at Nan Hospital. Furthermore, nasopharyngeal swabs (NPS) for *N. meningitidis* culture were collected on the investigation day, four days after ciprofloxacin prophylaxis. These swabs were randomly collected from 18 close-contact inmates who slept near the confirmed cases to identify asymptomatic carriers. NPS were also collected from all newly transferred inmates from other provinces since September 2023 to identify asymptomatic carriers who might be a source of infection. All cultured-growth specimens were sent to Bamrasnaradura Infectious Disease Institute for drug sensitivity tests and to the National Institute of Health for serogroup identification.

Environmental Study

An environmental study was conducted through surveys, observations, and interviews. This study walkthrough-surveyed and observed personal hygiene such as mask-wearing, social distancing, and hand-washing behavior. This study interviewed inmates and prison staff about inmates' daily activities, behaviors in buildings, and guidelines for respiratory disease screening and contact with inmates from outsiders, including inmates' relatives, doctors, dentists, and prison staff.

Statistical Analysis

This study performed descriptive analysis. Continuous data were presented using median with inter-quartile range (IQR). Categorical data were presented using frequency and proportion.

Ethics

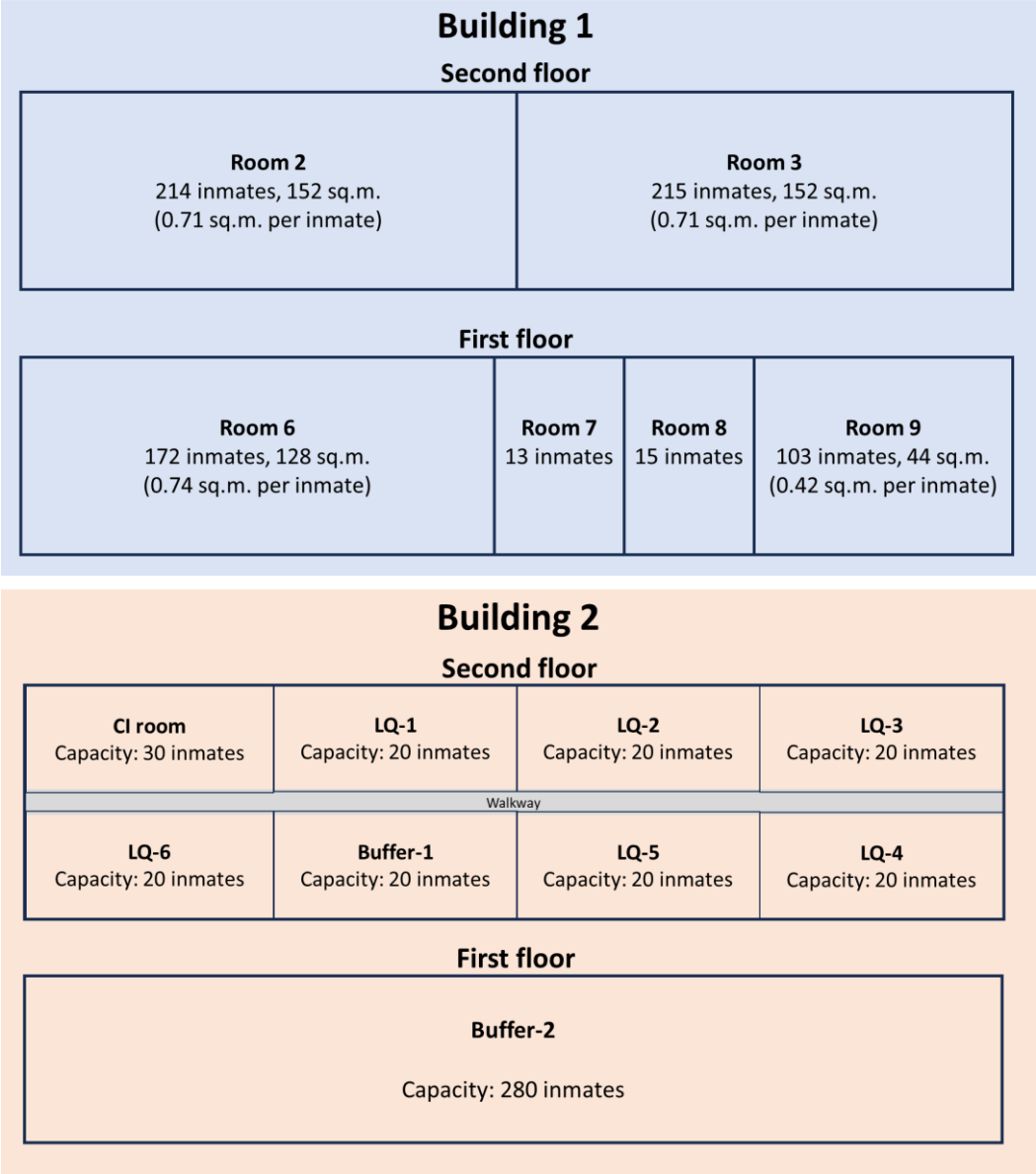
This investigation was conducted in response to a disease outbreak. The results do not include personal details. Confidentiality regarding case information was maintained throughout the study.

Results

The Prison and Its Responses to Previous Respiratory Disease Outbreaks

The provincial prison had 94 staff and 1,202 inmates. Among the inmates, 1,063 were male and 139 were female. Male and female inmate zones were completely separated. There were two buildings in the male zone, including Building 1 and Building 2.

Building 1 has six inmate rooms. The four main rooms were rooms 2, 3, 6, and 9. The inmate density was between 0.42 and 0.74 square meters per inmate. Building 2 served as a COVID-19 quarantine unit at least three months before the current outbreak to quarantine new inmates entering the prison who had COVID-19 or upper respiratory tract infection symptoms. The first floor was a common quarantine room called "Buffer-2" that could hold 280 inmates. The second floor was divided into six Local Quarantine rooms (LQ), one COVID-19 isolation room (CI), and one common quarantine room (Buffer-1) that could accommodate 20–30 inmates. All rooms were separated (Figure 1).



Due to the high turnover rate of inmates in Building 2, the inmate density could not be calculated.

Figure 1. Room plan and inmate capacity in Building 1 and Building 2 in a provincial prison, Nan Province, October 2023

During normal situations, all new inmates or returned from outside inmates had to complete a 15-day quarantine. This started with the first 5 days in LQ followed by Buffer-1 and Buffer-2 for 5 days each. Then inmates can enter Building 1 (Figure 2A).

The influenza outbreak in a provincial prison occurred on 27 Sep 2023, and there were 494 influenza-like illness cases which were male inmates. The highest number of cases was found on 1 October. Therefore, between 3 and 13 October, prison staff used the Buffer-2 room for the isolation of influenza-like illness cases and changed the quarantine flow to stay 10 days in LQ, then 5 days in Buffer-1 before moving to Building 1 (Figure 2B).

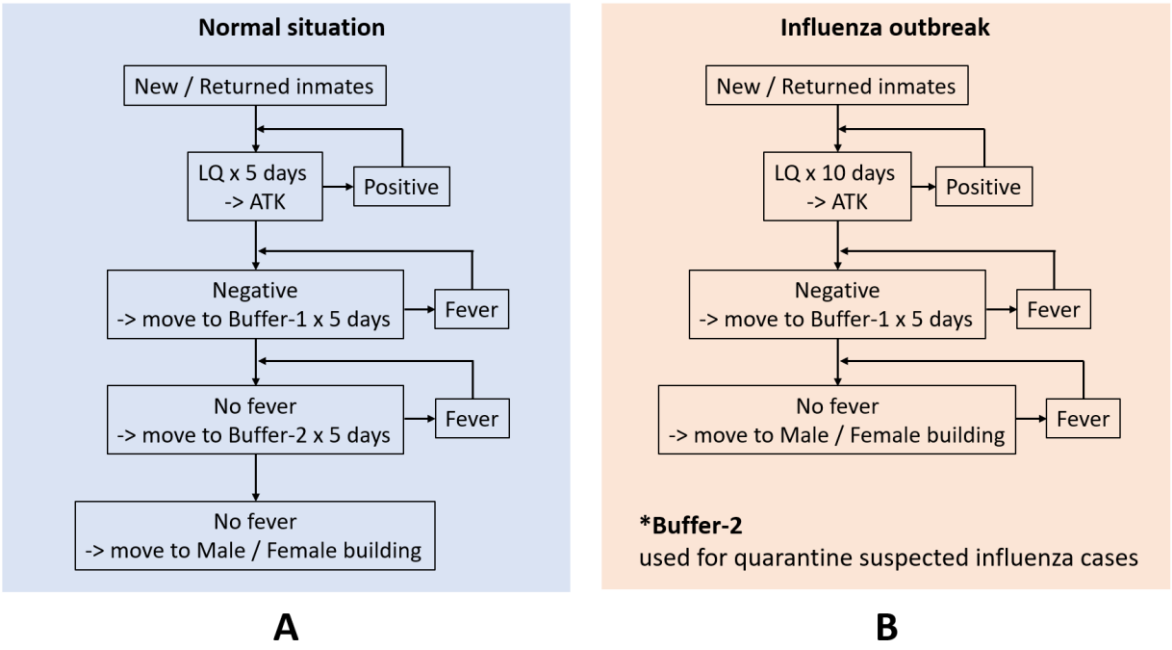


Figure 2. Diagram of quarantine guidelines during normal situation (Diagram 2A) and during influenza and meningococcal outbreak situation (Diagram 2B) in a provincial prison, Nan Province, October 2023

Descriptive Study

Between 2018 and September 2023, there were no reported cases of meningococcal disease in Nan Province in all databases. In addition, there was no detection of *N. meningitidis* in Nan Hospital's laboratory during this period.

Through active case finding, five confirmed and seven suspected cases were identified. Therefore, the total cases were 14, including the first two confirmed cases from notification. Considering only confirmed cases, the overall attack rate was 0.5% (7/1,296). All cases were Thai male inmates with a median age of 46 years (IQR 38.5–49.5 years). All confirmed cases stayed in Building 1 and lived in rooms 2, 3, and 6, which had room-specific attack rates of 0.9%, 0.5%, and 2.3%, respectively.

All confirmed cases and one suspected case were hospitalized and received treatment at the standard internal medicine ward of Nan Hospital. Two were diagnosed with meningitis, five with meningococcemia, and one with unexplained sepsis. One fatality (case fatality rate 14%) and two severe cases requiring endotracheal intubation were found. Among the cases, only one severe case had an underlying disease which was hypertension. The most common symptoms were fever (100%) and headache (71%), respectively (Figure 3).

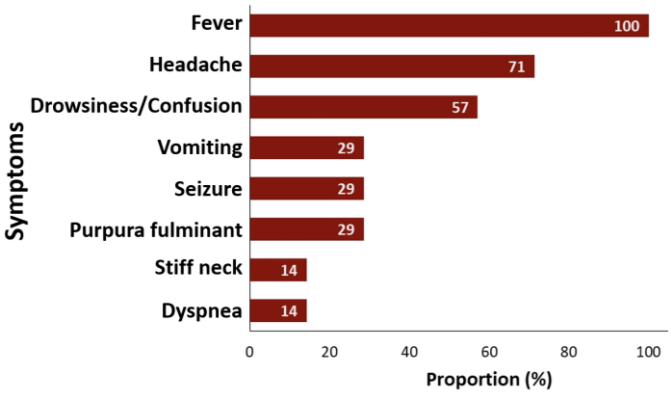


Figure 3. Symptoms of confirmed meningococcal disease cases in a provincial prison, Nan Province, 20 Sep–28 Nov 2023 (n=7)

The first confirmed case had the onset of symptoms on 12 Oct 2023. He had lived in this prison for one year in Room 2 and had not gone outside the prison in the past month. The next four cases developed symptom onset between 13 and 16 October. They all lived in Room 6 and had stayed in this prison for one to four months, two of them were suspected of influenza and were moved to the Buffer-2 room for quarantine on

3 October, and another two of them were new inmates who were isolated in Building 2 for two weeks (23 September–7 October) before they were moved to Building 1 Room 6. The fifth case had onset on 19 October, he was also a new inmate. In the first two weeks at Building 2 (20 September–4 October), he lived in the same room as one of the confirmed cases who moved to Building 1 Room 3. The last confirmed case reported onset on 28 October, he was a 53-year-old Thai male with an unknown underlying disease. He developed symptoms consisting of fever, seizure, and purpura fulminant. Although he was immediately transferred to Nan Hospital, he ended up dying in the Emergency Department. The doctor gave his provisional diagnosis of severe sepsis; *N. meningitidis* was the most suspected pathogen which was confirmed with a blood culture result in the next three days.

The results of meningococcal infection were not available until 22 October. Despite administering ciprofloxacin prophylaxis to all inmates on 23 October, one confirmed case emerged after that. It was later discovered that *N. meningitidis* was ciprofloxacin-resistant. Subsequently, on 28 October, all inmates received rifampicin as a second-time prophylaxis (Figure 4).

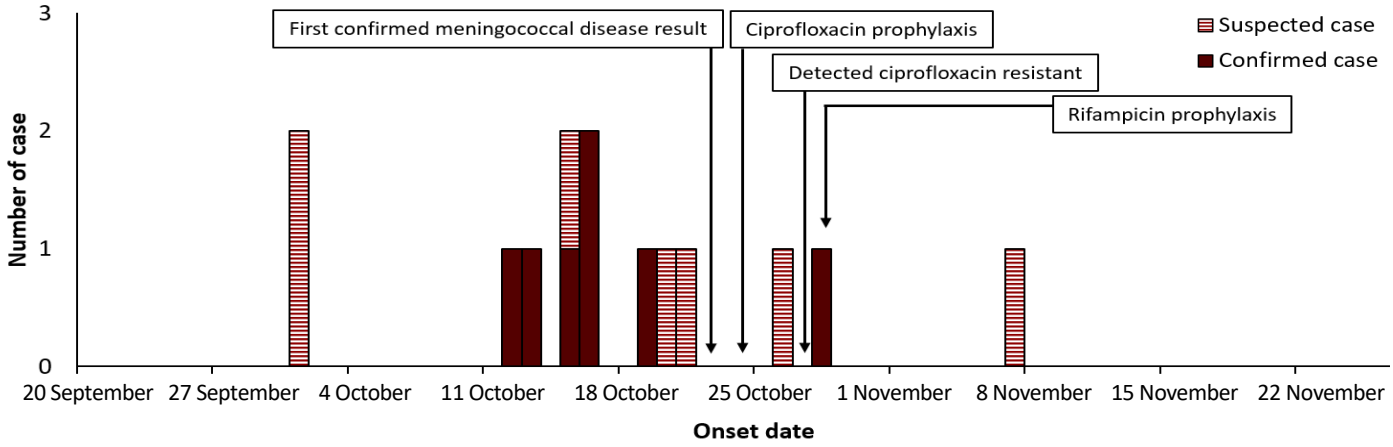


Figure 4. Number of meningococcal disease inmates in a provincial prison, Nan Province, 20 Sep–28 Nov 2023 (n=14)

There were two patterns of epidemiological linkage. The first was epidemiological linkage by close contact in the same room, while the second was close contact by sharing activities during the day. This study found three pairs of cases with the second pattern, either between suspected-confirmed cases or confirmed-confirmed cases (Figure 5).

Through contact tracing, at least 609 close contacts were identified, including 605 from close contact inmates and four from inmate's relatives who visited Nan Hospital. Additionally, there were nurses and other healthcare workers in the Emergency Department and male internal medicine ward where confirmed cases were admitted, but the exact number was not known due to data unavailable. No prison staff were identified as close contact. None of the close contact developed symptoms after prophylaxis with rifampicin.

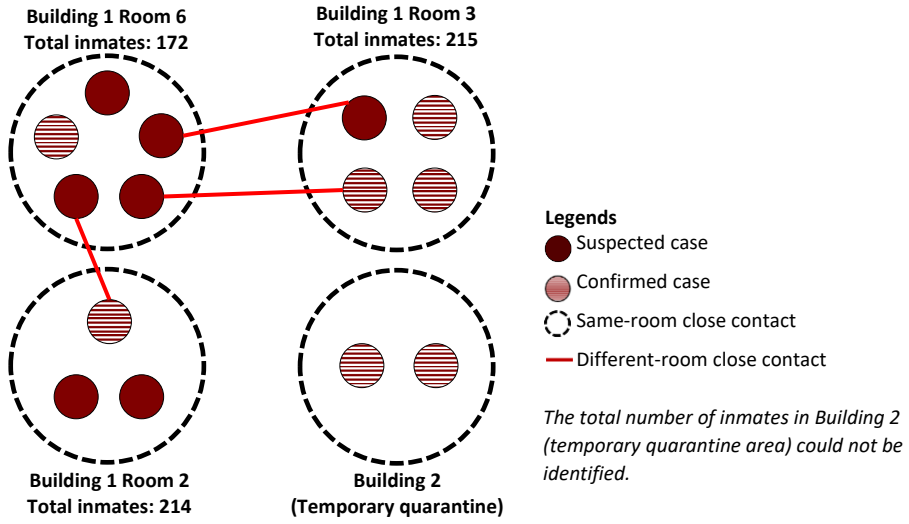


Figure 5. Epidemiological linkage among cases of meningococcal disease in a provincial prison, Nan Province, 20 Sep–28 Nov 2023 (n=14)

Laboratory Study

Neisseria meningitidis was detected from blood culture of five confirmed cases and CSF RT-PCR of the remaining two confirmed cases. No *N. meningitidis* was found from close contact inmates, and newly transferred inmates from other provinces (Table 1).

Drug sensitivity test showed that all five blood culture-growth specimens were sensitive to ceftriaxone, ceftazidime, and azithromycin; but resistant to ciprofloxacin and trimethoprim/sulfamethoxazole. Serogroup test also showed all five specimens were *N. meningitidis* serogroup B.

Table 1. Neisseria meningitis testing result among samples from confirmed cases, suspected cases, close contacts, and newly transferred inmates in a provincial prison, Nan Province, 20 Sep–28 Nov 2023 (n=37)

Type of individual	Type of Specimen	Number of samples send for testing	Result	Number of samples with pathogen (% positive)
Cases of meningococcal disease*	Blood culture	*9*	*N. meningitidis*	5 (55.56)
	CSF culture	2	-	0
	CSF RT-PCR	2	*N. meningitidis*	2 (100.00)
Close contact†	NPS culture	18	-	0
Newly transferred inmate	NPS culture	6	-	0

**Samples were collected from thirteen cases of meningococcal disease. A sample from one suspected case was not collected because he did not have any symptoms on the investigation day (28 Oct 2023). †There were 18 of 42 close contacts who slept near confirmed cases were randomly tested. CSF: cerebrospinal fluid. NPS: nasopharyngeal swab. RT-PCR: reverse transcriptase polymerase chain reaction.*

Environmental Study

Regarding the behavior of inmates, this study observed that there were less than 20 inmates among more than 200 inmates wearing facemasks during activities outside buildings. They often gathered in groups of 4–5 people. During meals, they used individual plates and spoons but shared water cups. Inside buildings, each room had only 1–2 water cups; therefore, inmates in the same room shared these water cups. In addition, inmates from different rooms could meet each other for about eight hours per day in some activities, such as breakfast time and factory work.

The guidelines for outsiders entering a provincial prison, in case of inmate's relatives visit, were as follows: relatives could visit through a tightly partitioned room and communicate with inmates by telephone. Bringing food for visits was not allowed. However, prison staff, vocational trainers, doctors, or dentists could enter the prison if they passed the fever screening and could contact directly with inmates. Through observation, no prison staff wore facemasks while working in this prison except staff who worked in an infirmary.

Action Taken

This study developed guidelines for surveillance of meningococcal infection for a provincial prison, starting with a daily check of whether inmates had symptoms that met meningococcal meningitis or meningococcemia criteria. Inmates who met the criteria were referred to Nan Hospital for diagnostic confirmation and close contacts were identified. Rifampicin re-prophylaxis would be given to these contacts if the suspected inmates had a diagnosis confirmed.

The provincial prison staff had done active surveillance for 20 days after the last confirmed case was identified and temporarily rescheduled inmate activities to reduce inter-room contact. Nan Public Health officers informed all close contacts about the symptoms of meningococcal disease and advised a hospital visit if symptoms occurred. After the end of 20 days of surveillance on 28 Nov 2023, no additional case was notified from a provincial prison.

Discussion

This event was a meningococcal disease outbreak in a provincial prison and its extent was limited to the prison. The pathogen was ciprofloxacin-resistant *N. meningitidis* serogroup B which, based on a published literature review, has never been reported in Thailand. Although there was documentation of ciprofloxacin-resistant *N. meningitidis* in Southern Thailand, the serogroup from that report was W-135.[15] There were reports of ciprofloxacin-resistant *N. meningitidis* serogroup B in many countries, potentially linked to the widespread use of fluoroquinolones.[11–13] In Thailand, ciprofloxacin was widely used to treat urinary tract infections.[16] The wide usage of ciprofloxacin can cause drug-resistant strains.[17] Since ciprofloxacin is commonly used for *N. meningitidis* chemoprophylaxis in Thailand, the occurrence of ciprofloxacin-resistant strain found in this event might indicate reduction in the prophylaxis effectiveness of the drug. The US-CDC and Thai Clinical Practice Guideline recommended that

rifampicin, azithromycin, or ceftriaxone could be used for chemoprophylaxis of *N. meningitidis* in case of ciprofloxacin-resistant strain.[10,18]

Previous studies showed that infection sources of droplets or close contact transmission disease outbreaks in prison probably came from outsiders or outside activities of inmates.[19,20] The NPS results from transferred prisoners showed no growth which means they were less likely to be an infection source. The possible explanation was *N. meningitidis* might have been introduced to a provincial prison by other asymptomatic carriers such as returned inmates from outside, outside staff, or prison staff.

Blood culture results of suspected cases, including the latest case were no growth. This indicated low infection probability among them.[21] Despite excluding suspected cases, there were still seven confirmed cases in this outbreak. It was considerably high compared to previous outbreaks in Thailand, which typically had 1–3 confirmed cases in closed environments such as prisons, military camps, and boarding schools.[7,22]

Several factors might have contributed to this outbreak's widespread infection, consisting of intra-room factors, inter-room factors, and the previous influenza outbreak. In a provincial prison, rooms in Building 1 had a density range 2–3 times higher than the standard (1.6 square meters per inmate).[23] This overcrowding increases the transmission of contagious diseases.[20, 24] Additionally, inmates shared water cups and rarely wore facemasks when doing their activities, further facilitating the spreading of disease. Inter-room factor was the inmates' daily schedules. Almost all activities during the day provided opportunities for inmates from different rooms to interact whether through talking, working, sharing meal, or other close-contact activities. Furthermore, the preceding influenza outbreak might also have promoted contact among inmates from different rooms when they were quarantined in the Buffer-2 room. There might have been carriers of *N. meningitidis* who were quarantined during the same period, potentially causing disease transmission. However, this study could not identify any carriers in this outbreak, so this remains a hypothesis to support the possibility of transmission among inmates from different rooms.

Limitations

This study had several limitations. First, information bias might have occurred due to confirmed cases forgetting the names of their close contacts, leading to difficulty in establishing a strong epidemiological linkage and close contact finding. Second, this study could not apply the NPS test in all close contacts due to limited resources and the nature of the carrier stage which may be transient.[25] For these reasons, the detection of asymptomatic carriers was limited, so it might have been difficult to identify how *N. meningitidis* entered the prison. Third, limitations to accessing CSF study results in hospitals made us unable to develop probable case definitions. Last, we could only walkthrough survey Building 2 of the provincial prison due to the regulation of the prison, so Building 1 environment description was limited. This study used data provided by prison staff such as the number of inmates, room plan, and asking inmates about the environment inside the building instead.

Public Health Recommendations

The provincial prison should encourage prison staff and outside staff to wear facemasks upon entry into the prison. Nan Provincial Public Health Office should monitor the situation of meningococcal disease in the community setting closely and continuously by starting with risk communication about the occurrence of this outbreak, then emphasizing all hospitals to be aware of meningococcal disease in patients with sepsis or meningitis symptoms. Drug sensitivity results in confirmed cases should be checked before starting antibiotic chemoprophylaxis to close contacts. However, in settings where close contact isolation is difficult, consider reviewing the drug-resistant situation in the area before starting antibiotics prophylaxis.

Conclusion

This event was the first meningococcal infection outbreak in a provincial prison and Nan Province in the past five years. The pathogen was *Neisseria meningitidis* Serogroup B with ciprofloxacin resistance. There were multiple possible sources of infection, which included personal hygiene, inmates' behaviors, daily activities, and the previous influenza outbreak appeared to be the factors that promoted the disease's spreading. Chemoprophylaxis with rifampicin, active surveillance, and limited inmate activities could help reduce disease spreading in the prison.

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Conflicts of Interest

The authors of this study have no conflicts of interest.

Suggested Citation

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An Investigation of Double Collisions of Pickup Trucks with Multiple Fatalities in Narathiwat Province, Thailand, October 2023

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Abstract

On 11 Oct 2023, a pickup truck crashed into a roadside tree in Narathiwat Province, southern Thailand after overtaking another vehicle. We conducted a descriptive study by reviewing medical records and interviewing rescuers, officers, survivors, and witnesses. We surveyed the collision site, reviewed video records, and used Haddon's matrix to assist with the analysis. A pickup truck carrying 11 passengers (including the driver) overtook another pickup truck on a stretch of road. The driver of the first pickup truck lost control due to tire deflation and crashed into a tree resulting in eight deaths (72.7%) and three hospitalizations (27.3%). All deaths were caused by severe head injuries. Multiple factors during pre-crash (vehicle unfamiliarity leading to improper passing sight distance and speeding), the crash (overloaded truck and a roadside tree), and post-crash such as poor communication, contributed to the severity of this event. The driver of the truck had no driving license and was unfamiliar with the vehicle. Six passengers were sitting in the truck's cab and three were in the cargo bed. Pre-crash and crash speeds were determined to be 80 and 100 kilometers per hour, respectively. The passing sight distance was grossly insufficient. Poor communication in the rescue process and the crowd of people at the scene resulted in improper emergency management. Strengthening law enforcement, increasing the number of speed limit signs, felling roadside trees, and practicing mass casualty incidents should be implemented.

Keywords: pickup trucks, motor vehicle crash, injury, head trauma, roadside tree, Thailand

Introduction

The United Nations General Assembly in 2010, underlined its aim to reduce deaths from road traffic accidents to 50% by 2020.[1] Thailand ranked first among ASEAN countries in terms of road traffic deaths.[2] Approximately 6% of Thailand's gross domestic product is lost annually to road traffic deaths and injuries.[3] The number of accidents from pickup trucks increased by 7% from 2020 to 2021 and fatalities from pickup trucks increased by 18% from 2021 to 2022.[4,5] The Department of Highways reported in 2022 that pickup trucks had the highest number of accidents among all vehicles.[6]

On 11 Oct 2023, two pickup trucks were involved in a side-swipe collision resulting in one crashing into a roadside tree on Rueso-Yi-ngo Road, Narathiwat Province in southern Thailand. Eight passengers died and three were injured. A joint investigation team from Office of Disease Prevention and Control 12 Songkhla, Narathiwat Provincial Public Health Office, Narathiwat Hospital, Yi-ngo Hospital, Rangae Hospital, Rangae Police Station, Narathiwat Provincial Police Office,

Narathiwat Disaster Prevention and Mitigation Office, Narathiwat District Highway, Provincial Land Transport Official of Narathiwat, Marubotok Subdistrict Municipality, Office of Insurance Commission, Road Accident Victims Protection Company Limited (Narathiwat Branch), and the traffic engineering expert from Princess of Naradhiwas University investigated from 16 to 17 Oct 2023 to provide recommendations to prevent accidents and reduce morbidity and mortality with future occurrences.

Methods

Descriptive Study

We interviewed rescuers from the municipality, staff from Yi-ngo, Rangae, and Narathiwat Hospital, Rangae Police Station, Narathiwat Disaster Prevention and Mitigation Office, Narathiwat District Highway, and Provincial Land Transport Official of Narathiwat, the traffic engineering expert, the cases who survived, and witnesses at the scene. We obtained the number of accident victims and cases, the driver's behavior, blood alcohol level, passenger seat map, and seat belt availability and use. An accident victim was defined as a person involved in this collision on 11 Oct 2023, including the drivers and passengers. A case was defined as an accident victim experiencing a physical injury.

We reviewed medical records from Yi-ngo, Rangae, and Narathiwat Hospital to collect injury characteristics and medication history. We collected details of emergency medical management at the scene and hospitals, including the type of rescue team, transferred hospitals and timelines and the time frame consisting of activation time (call received by the Emergency Medical Services Command and Control Center, also known as 1669 hotline to activation time), response time (call received by 1669 hotline to scene arrival), on-scene time (scene arrival to departure of the scene), and transfer time (scene departure to hospital arrival).[7,8] The traffic engineering expert reviewed available video footage 500 meters before the crash site. The pre-crash speed was estimated by calculating the distance traveled in kilometers (km) divided by time taken in hour (hr) and observing the other drivers' speed. The crash speed was estimated based on the American Association of State Highway and Transportation Officials (AASHTO) design guideline.[9,10]

We surveyed the collision site by inspecting the road type, number of lanes, and roadside objects. We measured the diameter of the affected tree and the distance between the road and the tree. The traffic engineering expert measured the tire mark between the index vehicle and the other party's vehicle to estimate the passing sight distance (PSD). We inspected the pickup truck wreckage at Rangae Police Station and reviewed the news from social media platforms such as webpages and Facebook specifically for images and information about the collision, impact sites, vehicle damage, and weather conditions. We reviewed a report from the Provincial Land Transport Official for the vehicle's appearance, date of tax expiration and inspection, year of tire production, and driving licenses of the drivers.

Haddon's matrix, a conceptual model in injury approach, was used to describe possible risk factors in the aspects of human, vehicle, road, and environment during pre-crash, crash, and post-crash periods.[11] Each factor was determined by the consensus of the joint investigation team.

Ethics

This study was a part of routine investigation and response activities of the Thai Department of Disease Control, Ministry of Public Health, ethics approval was not required.

Results

Location of the Accident Site and Event Description

The accident occurred on a section of the 4058 Road (between the 3rd and 4th-kilometer mark) in Marubotok Subdistrict, Ra-ngae District, Narathiwat Province. It was a straight 2-lane highway, asphaltic concrete, flat road with a smooth surface and clear road line. There was no speed limit sign, and trees were located along the roadside (Figure 1). Close to the accident site were Marubotok Subdistrict Municipality and two district hospitals: Yi-ngo Hospital, the nearest hospital—about 6 kilometers away, and Rangae Hospital—about 12 kilometers away. Narathiwat Hospital (24 kilometers away), the provincial hospital, was associated with the Emergency Medical Services Command and Control Center of Emergency Medical Services section.

On 11 Oct 2023, at 12:15 PM the index vehicle (Vehicle A), carrying 11 people including the driver, departed from a house in Rueso District, Narathiwat Province, heading to Mueang District, Narathiwat Province (Figure 1). At 12:48 PM pickup truck A hit another pickup truck (Vehicle B), carrying six passengers including the driver, while trying to overtake it and another vehicle (Vehicle C) on the right. A car (Vehicle D) was moving in the opposite lane. However, the PSD was insufficient causing Vehicle A to quickly swerve back into its lane, resulting in a collision between its wheel and those of Vehicle B.

After the collision, the wheel rims of both vehicles were fractured. The Vehicle A experienced tire deflation, lost control and crashed into a 40-centimeter-in diameter roadside tree located four meters from the road. On the day the accident occurred, the sky was clear with no rain and good visibility.

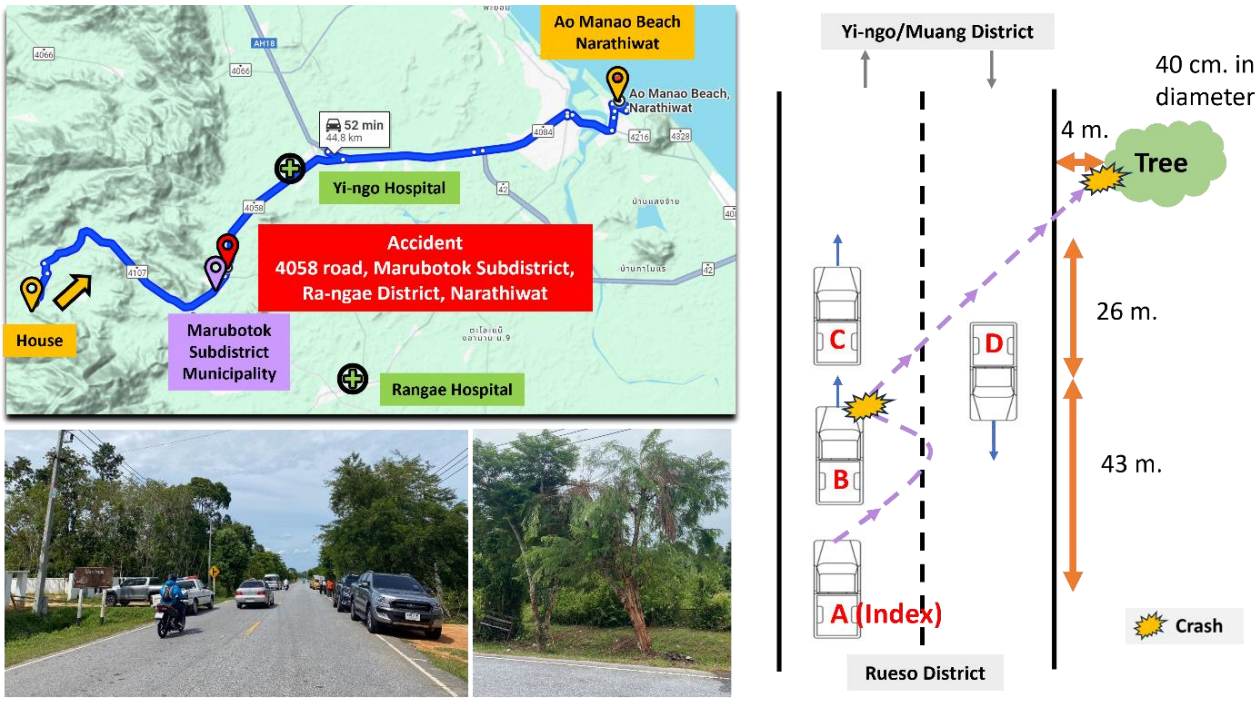

Figure 1. A road map from departure to destination, accident location, and collision diagram of the accident, Narathiwat Province, 11 Oct 2023

Characteristics of Injury

There were 17 accident victims, 11 in Vehicle A and six in Vehicle B. All six passengers in Vehicle B were uninjured. However, the 11 passengers in Vehicle A were all injured, including eight deaths (72.7%) and three hospitalizations (27.3%). Male-to-female ratio was 0.8:1. The median age was 15 years (interquartile range 11–30 years).

The passenger seat map and characteristics of body injured are shown in Figure 2. Six passengers were sitting in the cab, three in a cargo bed. The driver and another passenger were seated in the front. Among people who sat in the cab, 67% died (4/6) which was the same percentage as in the cargo bed (2/3). After the crash, six people were found outside the pickup truck and 50% of them died.

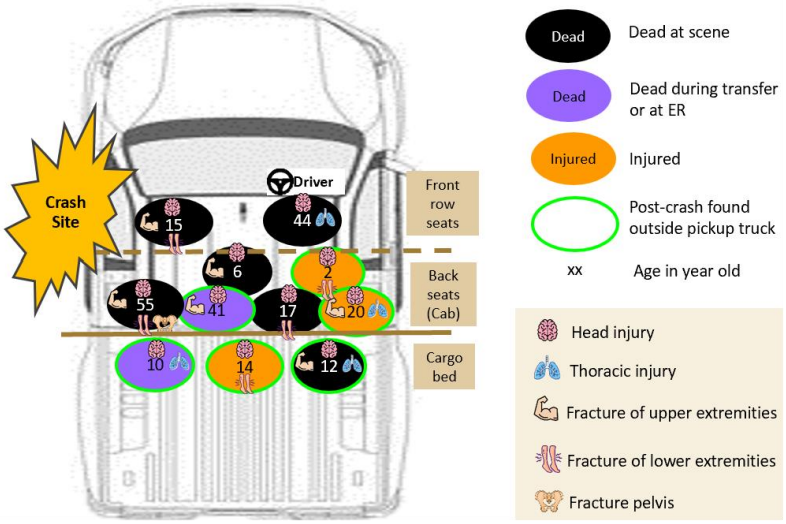

Figure 2. The passenger seat map in the index vehicle (Vehicle A) and characteristics of body injured in the accident, Narathiwat Province, 11 Oct 2023

For those who were found outside the truck, male-to-female ratio of the dead was 2:1. The mean age of the dead was higher than the survivor at 21 years (range 10–41 years) compared to 12 years (range 2–14 years). The dead had more severe head injuries than survivors (3:1) and also more thoracic injuries and fractured

upper extremities (2:1). Regarding wound type, the dead had a higher incidence of open extremity wounds (2:1) compared to the survivors. All of the dead were unresponsive at the scene and in a coma state at the emergency room, while only one survivor was unresponsive.

Among all 11 injured, severe head injury is the highest region of injury accounting for 81.8% followed by fractures upper and lower extremities at 54.5% and 45.5%, respectively. All eight dead had severe head injuries (100%), compared to one injured case (33.3%) (Figure 3).

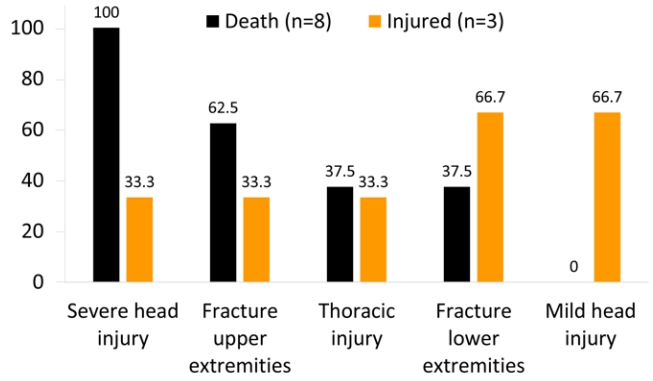

Figure 3. Percentage of cases by body region of injury among deaths (n=8) and injured cases (n=3) of the accident, Narathiwat Province, 11 Oct 2023

Pre-crash Period

The driver of Vehicle A had no driving license. He was not the vehicle owner and rarely drove it. He had a positive urine test for methamphetamine in 2018. A case said that the driver had a history of fast driving and did not sleep at night. Seat belts were present in the front-row seat only and were not used. The driver's blood alcohol level, measured at Rangae Hospital one and one and a half hours after the accident, was negative (<10 mg/dL) using the alcohol dehydrogenase method. Other substances were not tested.

Vehicle A was a Toyota Hilux Vigo Champ. The tires were produced in 2018 and the treads were worn. Vehicle B was a Mitsubishi L200 Strada with customized wheels and tires protruding beyond the fenders (Table 1).

Pre-crash speed was estimated to be 80 km/hr based on video footage that captured Vehicle A traveling 88.2 meters in four seconds and by observing other vehicles' speed, which was also 80 km/hour. The estimated PSD was 43 meters by measuring the distance retrieved from the tire mark on the road between Vehicle A and Vehicle B before Vehicle D was approaching the opposite lane.

Crash Period

The crash speed was assumed to be 100 km/hr according to the AASHTO design guideline.[11] The roof and passenger area of Vehicle A collapsed with severe damage to the passenger cabin. The left front and left back rim wheels were broken. The right front rim wheel of Vehicle B was also broken (Figure 4).

Table 1. General information of the index vehicle (Vehicle A) and other party's vehicle (Vehicle B)

General information	Vehicle A	Vehicle B
Brand and Model	Toyota Hilux Vigo Champ	Mitsubishi L200 Strada
Type of vehicle	Van & Pickup (Type3)	Van & Pickup (Type3)
Tax expiration date of the vehicle	20 Jun 2024	14 Oct 2024
Latest inspection date of the vehicle	29 Mar 2023	NA
Color	Black	Green, black
Transmission type	Manual	Manual
Engine size	4-engine 2,494 cc. 144 horsepower	4-engine 2,835 cc. 101 horsepower
Dimension	5,135 x 1,760 x 1,720 millimeters Vehicle 1,600 kilograms weigh Load 1,050 kilograms weigh Total weight 2,650 kilograms	4,935 x 1,695 x 1,710 millimeters Vehicle 1,510 kilograms weigh Load 960 kilograms weigh Total weight 2,470 kilograms
Original safety and protective systems	Safety belts located at the front row seats only	Safety belts located at the front row seats only
Passenger capacity	2 passengers	2 passengers
Year of production	2012	NA
Any modification that might affect vehicle's safety and performance	The tires were produced in 2018 and the tires' treads were worn down	The wheels and tires were customized and stick out past the fenders

NA: not available.

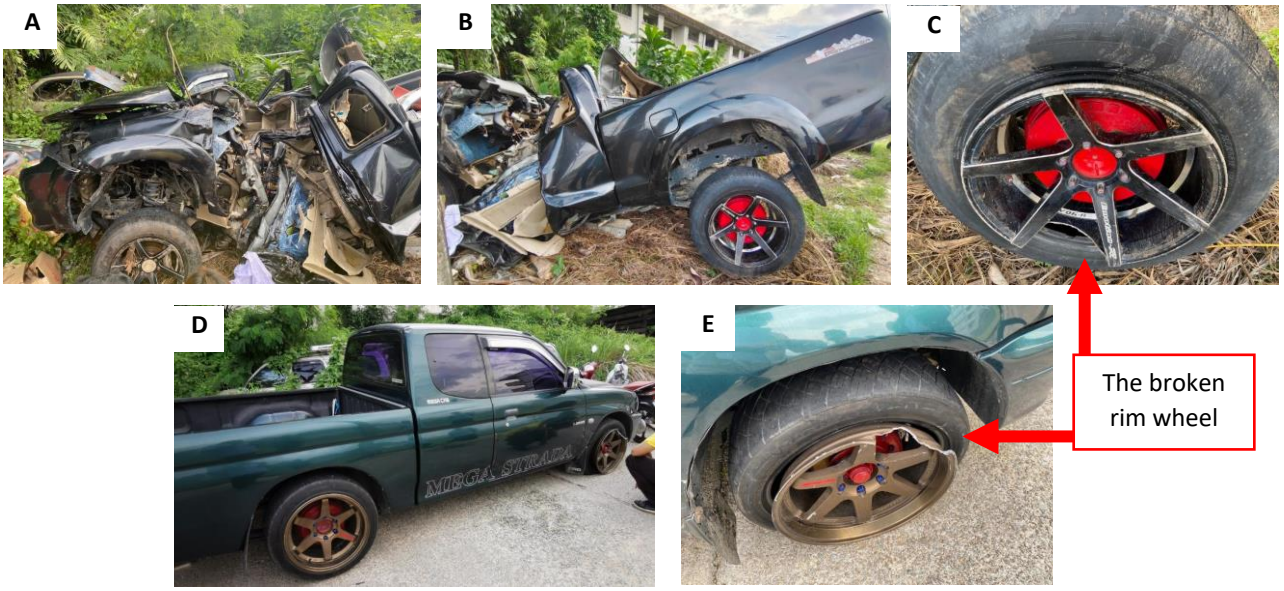

Figure 4. The index's vehicle (Vehicle A) (A–C) and other party's vehicle (Vehicle B) (D–E) of the accident, Narathiwat Province, 11 Oct 2023

Post-crash Period

After the accident, staff from Yi-ngo Hospital were notified by the Center and planned to go to the scene but the Municipality rescue team arrived at the scene first and transferred 5 red-tagged cases to Yi-ngo Hospital already (Figure 5). Staff from Rangae Hospital received the message from the center to stand by at the hospital because the center had already dispatched staff from Yi-ngo Hospital to the scene. Rangae Hospital staff were then notified to come to the scene and found only six black-tagged cases. The extrication tools arrived approximately 45 minutes after the collision because there were no extrication tools in this district. They were provided by the Narathiwat Methatham Foundation in Mueang District located 30 kilometers away. After that, Rangae Hospital staff transferred six dead cases to Rangae Hospital.

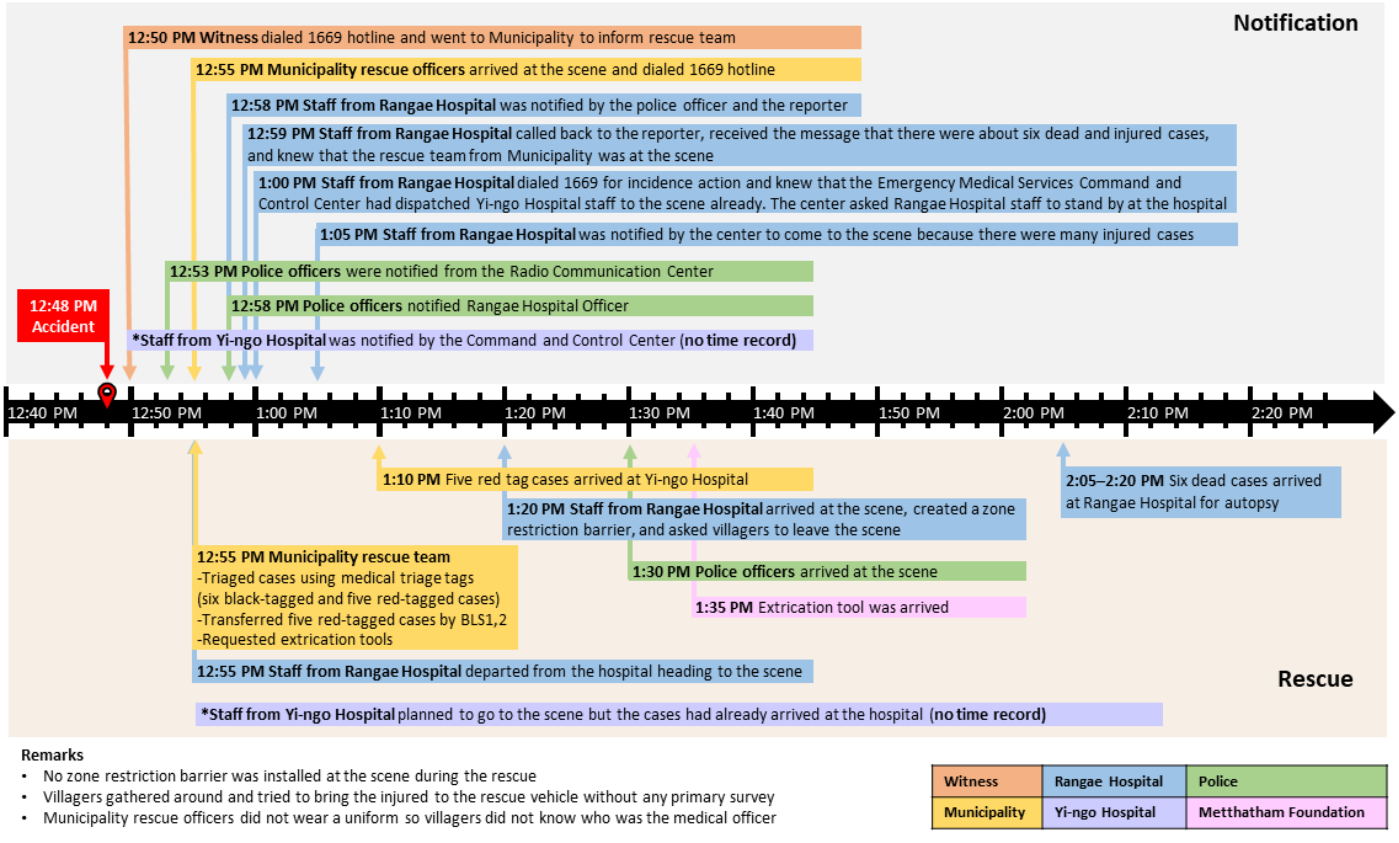

Figure 5. Emergency medical service timeline by notification and rescue process of the accident, Narathiwat Province, 11 Oct 2023

At the crash site, no zone restriction barriers were installed. Villagers gathered around and tried to move the injured to a rescue vehicle without performing a primary survey. Municipality rescue officers did not wear a uniform so villagers did not know who was the medical officer resulting in difficulty in leading the team.

Basic life support teams from the municipality transferred five red-tagged cases to Yi-ngo Hospital by ambulance and patrol car, of whom one died during the transfer, one died at the emergency room and three were referred to and hospitalized at Narathiwat Hospital. All six black-tagged cases, who were dead at the scene were transferred by the advanced life support team from Rangae Hospital to Rangae Hospital by ambulance. All the cases had no pre-hospital treatment. The response time was five minutes for the basic life support team (12:50 PM to 12:55 PM) and 30 minutes for the advanced life support team (12:50 PM to 1:20 PM) (Table 2).

Table 2. Pre-hospital emergency medical service by type of rescue teams, type of cases' medical triage tag, and the duration of time of the accident, Narathiwat Province, 11 Oct 2023

Type of Rescue team	Organization	Duration in this event/goal[15, 16] (minutes)				Type of transferal cases (number)	Type of transferal car	Pre-hospital Treatment	Transferal hospitals
		Activation time	Response time	On scene time	Transfer time				
BLS1	Municipality	NA*/2	5/4	NA†/10	NA†/10	Red (3)	Ambulance	None	Yi-ngo
BLS2	Municipality	NA*/2	5/4	NA†/10	NA†/10	Red (2)	Patrol car	None	Yi-ngo
ALS1	Rangae Hospital	NA*/2	30/8	NA†/10	NA†/10	Black (6)	Ambulance	None	Rangae

**No information about activate time. †No information about the time they getting out of the scene. ☐ Under standard, ☐ Equal/over standard. BLS: basic life support. ALS: advanced life support.*

Possible Risk Factors

In the pre-crash period, human factors included driver unfamiliarity with the vehicle, unlicensed driving, improper PSD, and speeding. Environmental factors included the absence of speed limit signs on the road and vehicle factors included worn tire treads. In the crash period, overloading passengers, absence and non-use of safety belts, and roadside trees increased the severity of injuries. In the post-crash period, unclear communication between rescuers and bystanders, improper management at the scene, difficulty in accessing and evacuating accident victims, and delays in the provision of extrication tools may have contributed to a higher fatality (Table 3).

Table 3. Haddon's matrix applied to the accident, Narathiwat Province, 11 Oct 2023

	Human	Vehicle	Road and environment
Pre-crash	• Unfamiliarity and unlicensed driving • Improper PSD • Speeding	• The tires were produced in 2018 and the tires' treads were worn down	• No speed limit sign
Crash	• Overloading passenger • Did not use of seatbelts	• A side-swipe collision • Additional crash on the roof of the pickup truck and severe structural damage • Absence of safety belts and/or safety equipment at back row seat and cargo bed	• Crashed into a 40-centimeter in diameter roadside tree
Post-crash	• Stuck in the vehicle (waiting for extrication tools for 45 minutes)	• Severe structural damage leading to difficulty in rescue	• Unclear notification and communication • Improper management at the scene (inappropriate practices by villagers, no primary survey) • Difficult to access and evacuate (crowded people, not able to identify who were officers, improper zone management)

Action Taken

The relevant authorities attended a meeting to assess risks and provide recommendations. We proposed and agreed on environmental and roadside management including adding speed limit signs along one kilometer of this road and felling roadside trees.

After this investigation, the speed limit signs were installed at the accident location. The Narathiwat Provincial Public Health Office emphasized the Emergency Medical Services Command and Control Center to dispatch a rescue team to the accident scenes promptly. They also emphasized that all traffic incidents be systematically recorded. The Road Safety Operations Center Committee of Narathiwat Province convened a meeting to plan and structure the incident command system in mass casualty incidents and to extract lessons learned from this accident. Training sessions for community emergency medical responders were organized. They recommended posting the 1669 hotline stickers at all hospitals in Narathiwat Province and distributing them to villagers in the community. The Narathiwat Provincial Police Office has enforced 10 road traffic prevention measures, launched by the Royal Thai Police, and monitored law enforcement monthly.

Discussion

This accident resulted in the tragic loss of eight lives. Many factors were related to the accident and its severity including vehicle unfamiliarity, which is known to be associated with increased injury severity.[12] The driver of vehicle A had no driving license and was unfamiliar with this vehicle, resulting in the improper PSD and speed. In this event, the PSD was seven times lower than the recommended distance. According to the AASHTO, the PSD is the distance a driver must be able to see ahead to complete a safe overtaking maneuver.[9,10] In this event, the passed vehicle's speed was 80 km/hr and the passing vehicle's speed was 100 km/hr, therefore the PSD should be 320 meters.[10] Vehicle familiarity also influences faster perception-reaction time, which is the time required for drivers to respond to roadway events.[10,13,14]

Pre-crash speed exceeded the legal limits of 65 km/hr for pickup trucks and 60 km/hr for pickup trucks with passengers in the cargo bed.[15,16] Speeding is one of the most important human factors contributing to road traffic injuries and deaths.[13,17] An in-depth investigation showed that speeding accounted for about 62% of all crashes in Thailand.[18]

Passenger overloading violated the law and increased the risk of injuries. According to the Royal Thai Police Act in 2023, no more than three passengers are allowed to sit in the cab and no more than six passengers are allowed in the cargo bed.[15] Overloading impeded acceleration, complicated overtaking, and increased severity of injury for cargo bed passengers due to lacking safety equipment.[13,14,19–21]

Roadside trees are one of the most common and serious roadside hazards, contributing to 72% of the roadside crashes on Thai highways.[14,17,20–23] A clear zone is an area beside a road that should be free of hazards to allow drivers of errant vehicles to recover.[23] The width of a clear zone depends on many factors such as road type, design speed, and traffic volume.[24] Trees with a diameter exceeding 10-centimeter are defined as roadside hazards.[23] Trees should not be located within five meters of the road unless they are smaller than 10 centimeters in diameter.[23–25]

Post-crash difficulties in rescue also contributed to the increased morbidity and mortality. Unclear communication about the number of injured cases and the type of team that arrived at the scene resulted in the delay of advanced life support team. Crowds, absent zone restriction barriers, and unidentified rescue officers led to difficulties in accessing and evacuating injured victims. Villagers' inappropriate practice of attempting to move injured victims without performing a primary survey was evident in this incident. Delayed extrication tools increased mortality for stuck passengers.[26]

Limitations

There were limitations in our investigation. We could not obtain the driver's behavior directly. We relied on interview with their relatives and reviews of medical records and driving license. Although the driver had a history of methamphetamine use, substance use could not be confirmed. There were no video records at the collision site. Therefore, the crash speed was estimated based on AASHTO guideline. For victims found outside the truck, we could not ascertain their distance from the truck or the tree immediately after impact, nor whether they had collided with external objects. Lastly, official records from the rescue team were unavailable. Therefore, the activation time, on-scene time, and transfer time were unknown. Instead, we interviewed personnel, officers, cases, and witnesses for time estimates.

Recommendations

For short-term goals, the Provincial Public Health Office and the Emergency Medical Services Command and Control Center should provide knowledge of first aid management to villagers, and practice for mass casualty incidents in the community.

For the long-term goal, the Department of Highways should conduct surveys to identify trees eligible for removal to minimize roadside injury. Additionally, in collaboration with a community referendum, efforts should focus on felling roadside trees if they have a diameter exceeding 10 centimeters and are located within five meters of the road. Furthermore, police officers should strengthen law enforcement in terms of the number of passengers in vehicles and/or propose legislation to reduce the number of passengers allowed in the cab and cargo bed of the pickup truck. Finally, the Department of Land Transport should provide education on these rules to individuals who renew or apply for a driving license.

Conclusion

Double collisions, including a side-swipe collision of two pickup trucks, followed by one truck crashing into a roadside tree in Narathiwat Province on 11 Oct 2023, resulted in eight deaths. Various factors contributed to the high morbidities and mortalities. These include the driver's unfamiliarity with the vehicle, poor decision-making, speeding, vehicle overloading, roadside hazards, and difficulties in rescue. Strengthening law enforcement in inspecting driving licenses and the number of passengers, and increasing the number of speed limit signs along the road should be enhanced. Felling roadside trees and practices for mass casualty incidents should be implemented to reduce future accidents, morbidity, and mortality.

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Conflict of Interest

This study declared no conflict of interest.

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

During the preparation of this work, the authors used ChatGPT in order to correct grammar. After using this tool/service, the authors reviewed and edited the content as needed and took full responsibility for the content of the publication.

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Prevalence of, and Factors Associated with, Unmet Healthcare Need in Urban Refugees and Asylum Seekers in Bangkok, Thailand: a Mediation Analysis

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Abstract

This study examines the prevalence of, and factors mediated to, unmet healthcare need of urban refugees and asylum seekers (URAS) in Thailand. In 2019, a cross-sectional survey of 181 URAS was merged with Thai Health and Welfare Survey data (total n=3,122). Self-reporting questionnaire was applied. Unmet healthcare need, defined as a status where a person needed health examination or treatment within the past 12 months, but he or she did not receive it, were analysed using multivariable logistic regression within a concept of mediation analysis. URAS were younger and had lower household economic status than Thais, and almost all URAS were uninsured. Most URAS suffered from a high prevalence of unmet healthcare need, 54.1% (range 31.4–100.0%) for outpatient (OP) care and 28.0% (range 0–83.3%) for inpatient (IP) care, while unmet healthcare need prevalence amongst Thais was 2.1% for both OP and IP care. For OP care, the direct effect of URAS status (predictor) on unmet healthcare need (outcome) showed a significant adjusted odds ratio (AOR) of 8.8 (95% CI 1.3–58.6), and a total effect (combining direct effect and indirect effect where insurance status served as a mediator) had AOR as large as 42.3 (95% CI 26.4–67.8). A significant total effect was also observed for IP care (AOR 13.1, 95% CI 7.8–22.0). Since most URAS substantially suffer from a lack of insurance coverage and this markedly influenced healthcare inaccessibility, policymakers should prioritise expanding insurance coverage towards URAS to promote health equity for all.

Keywords: urban refugee, asylum seeker, unmet healthcare need, healthcare, Thailand, mediation analysis

Introduction

According to the World Migration Report 2022 by the International Organization for Migration, one in every thirty people lives in a country other than his/her country of birth.[1] Various factors are responsible for global mobility, including political conflicts and violence, as well as lack of economic opportunities.[2]

Migration is recognised as a key social determinant of health, with migrants mostly suffer from social discrimination, language barrier, and exclusion from migrant-inclusive health policies in destination countries.[3] The COVID-19 pandemic has further highlighted existing healthcare inequities amongst migrants.[4] The United Nations and the World Health Organization have called for migrants' inclusive health policies in the host nations.[5,6]

Amongst several kinds of cross-border migrants, forcibly displaced people; including refugees and asylum seekers (RAS), are one of the most neglected populations in society. RAS represented nearly one-third of all immigrants worldwide.[7]

Thailand, a key migration hub in Southeast Asia, relies significantly on workers from Cambodia, Lao People's Democratic Republic, and Myanmar (CLM).[8] Thailand's demand for foreign workers is growing rapidly due to a relative lack of internal labour force.[9,10]

Since implementing the National Health Insurance Act in 2002, Thailand has made substantial progress toward universal health coverage. Public insurance covers all Thai nationals.[11–13] The Thai government has ensured healthcare access for CLM migrant workers and their children by establishing the Health Insurance Card Scheme in 2004 which provides a

comprehensive benefit package, close to public insurance for Thai populations.[14,15]

Compared to CLM foreign workers, the well-being of RAS in Thailand is highly neglected. They are ineligible for public health insurance schemes, with only a few having private insurance. Although refugee camps along the Thai border are frequently supported by several non-profit or non-governmental organizations (NGOs), the health of urban refugees and asylum seekers (URAS) in urban settings remains largely neglected. Moreover, they are at risk of detention and deportation.[16] Previous studies have revealed numerous barriers limiting URAS healthcare access.[17–21]

This study therefore aimed to explore prevalence of and factors associated with unmet healthcare need amongst URAS in Bangkok, Thailand. This study also hypothesized that the lack of insurance played a critical role in mediating the effect of URAS on unmet healthcare need as described later in the methods section.

Methods

Study Design, Populations, and Samples

This study revisited data from an earlier project focused on examining healthcare access, specifically unmet healthcare needs, within the URAS population against the Thai population.[18] Bangkok was selected due to its significant URAS population.

Data was integrated from both primary and secondary sources, namely, the 2019 Health and Welfare Survey (HWS).[22] This was a cross-sectional primary survey of URAS conducted between October and December 2019. The HWS was a biennially nationwide survey on the Thai population conducted by the National Statistical Office and International Health Policy Programme, Ministry of Public Health (MOPH).

For the primary survey in URAS, this study communicated with the Bangkok Refugee Centre (BRC), supported by UNHCR, to promote URAS health. The URAS enrolled in this study included only Pakistanis, Vietnamese, Cambodians, Somalis, Afghans, Palestinians, Chinese, Sri Lankans, Iraqis, and Syrians, the top-ten most common nationalities in Thailand (n=3,021). Note that CLM migrants are considered economic migrants—hence being excluded from this survey. This study then sampled 206 URAS. Of these 206 samples, 181 completed the survey. This data was combined with responses from the Thai population in the 2019 HWS (n=2,941), resulting in a final dataset of 3,122 observations.

Sample Size Calculation, Sampling Methods, and Survey Design

This study employed the prevalence of unmet healthcare need to determine the sample size using the formula:

$$n = \frac{(Z_{(1-\frac{\alpha}{2})}\sqrt{2PQ} + Z_{(1-\beta)}\sqrt{P_1Q_1 + P_2Q_2})^2}{(P_1 - P_2)^2}$$

In this formula, this study set $\alpha = 0.05$ for significance level; $\beta = 0.2$ for power; $Z_{(1-\frac{\alpha}{2})} = 1.96$; $Z_{(1-\beta)} = 0.84$; $P_1 = 0.11$; $Q_1 = 1 - P_1$; $P_2 = 0.012$; $Q_2 = 1 - P_2$; $P = \frac{(P_1+P_2)}{2}$ and $Q = 1 - P$. P_1 represents the unmet healthcare need prevalence in URAS samples, while P_2 represents the similar prevalence in the Thai population. P_2 was suggested to be 0.012 based on Thammatacharee et al.[23] For P_1, this study used the prevalence of unmet healthcare need of refugees in Italy by Busetta et al.,[24] suggesting an 11% prevalence. Accounting for 20% incomplete information, this study aimed for at least 140 Thais and 140 URAS samples. The available data from Thai respondents in the HWS exceeded the required sample size. For URAS sampling, this study used stratified random sampling on the BRC roster, proportionate to size with respect to age, gender, and nationality. This study ended up with 181 URAS and 2,941 Thai participants.

Data Collection

All the selected participants were asked to visit the BRC office to complete the paper questionnaire. Financial support was provided as compensation for travelling costs (about US$10 each, using the exchange rate on 1 Oct 2019). Phone interviews were conducted for those unable to travel. Legal guardians responded for children under 15. The questionnaire was translated into the participants' language and took approximately 30 minutes.

Questionnaire Design and Key Determinants

The questionnaire for the URAS survey contained two sections: (i) demographic data and (ii) profile of unmet healthcare need.

In the first section, demographic questions consisted of gender, age, education background (primary, secondary or degree and above), health insurance status (public, private, or uninsured) and household monthly income. Note that, by the Thai employment laws, URAS are not eligible to be insured by the public insurance scheme. However, some URAS might possess private insurance. For convenience, age was categorised into three groups (≤15 years, 16–60 years, and >60 years). This study created a new binary variable, 'household economy', by dividing the

household monthly income into two divisions, 'below average' and 'above-or-equal average' by a cut-off at US$ 1,428 (using the exchange rate on 8 May 2020)—the mean monthly household income amongst Bangkok residents.[25]

In the second section, participants assessed their unmet healthcare need based on self-reported responses. This study defined unmet healthcare need as a status where a person reported that he or she required health examination or treatment for any health issues within the past 12 months, but he or she did not receive or failed to seek it. In the questionnaire, this study asked each respondent to report whether he or she had ever felt unwell and needed healthcare, but not received it during the last 12 months. This study categorised this question into outpatient (OP) and inpatient (IP) care. This study also asked the participants to provide the most important cause of unmet healthcare need, for instance, 'unable to afford the treatment cost' or 'long waiting times.'

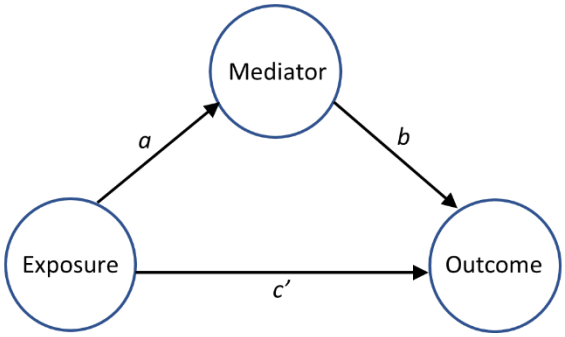
Statistical Analysis

All statistical analyses were performed by Stata v14.0 (US-serial number: 401406358220). This study divided the analysis into four parts: (i) univariable analysis, (ii) multivariable logistic regression, (iii) mediation analysis, and (iv) descriptive analysis on the most compelling reasons for unmet healthcare need.

First, in univariable statistics, all categorical variables were shown as frequency and percentage, while age and household economy were expressed by median and percentile. Chi-square test, Fisher's exact test, and Mann-Whitney U test were performed to compare the proportionate difference of unmet healthcare need between Thais and URAS.

Second, in multivariable logistic regression, unmet healthcare need was the main dependent variable, and insurance status was the main predictor, adjusted for economic status of household, age, gender, and nationality.

Third, mediation analysis was conducted to complement multivariable analysis, considering URAS status as the main predictor and experiencing unmet healthcare need as the main outcome, with insurance status as a mediator. This idea was supported by the results from univariable analysis and the fact that URAS are ineligible for public insurance. The simplified concept of mediation analysis is as follows. This study first regressed the outcome on the predictor, the mediator and the covariates. The coefficient of the predictor was considered direct effect (suppose, θ). Then this study regressed the mediator on the predictor and the covariates. Suppose the predictor coefficient at this time is ϕ, the indirect effect is the product of θ and ϕ. The sum (in linearity) between direct and indirect effect is the total effect. This study used 'PARAMED' package in STATA. Gender, age group and economic level were treated as covariates. Results were presented in the form of adjusted odds ratio (AOR) like multivariable logistic regression, but sorted into total effect, direct effect, and indirect effect (Figure. 1).



A mediation analysis was applied in this study.[26] a and b illustrate the path coefficients from the exposure to the mediator and the mediator to the outcome, respectively. c' is the path coefficient of direct effect from the exposure. The product of a and b display the mediation effect of the exposure on the outcome through the mediator. The sum of a b and c' (in linear system) is total effect.

Figure 1. Causal diagram for performing mediation analysis

Fourth, this study focused on URAS suffering for unmet healthcare need. This study began by descriptively analysing the frequency of the most important reasons contributing to unmet healthcare need from the URAS' perspective.

Ethics

This study received ethics approval from the Institute for the Development of Human Research Protection under the reference number IHRP592/2562. Written consent was obtained from the participants.

Results

Demographic Profiles

A total of 3,122 records were entered into the analysis, of which 5.8% were URAS (n=181). Among the URAS group, 88.4% (n=160) were refugees and 11.6% were asylum seekers (n=21). Males and females in both Thais and URAS were almost equal in number. The median age of Thais was 42 years. In contrast, the median age of URAS was 23 years. Approximately 65.4% of Thais completed secondary education or higher, compared to 36.5% of URAS participants. Thais' median household income was about fivefold greater than URAS (US$ 469 *versus* US$ 188; using the exchange rate on 8 May 2020). While almost all Thais were insured by either public or private insurance (99.8%), only 2.2% of URAS were insured.

More than half of URAS (54.1%) had unmet healthcare need for OP care and about 28.0% for IP care. These figures presented with statistical difference compared with Thais (*p*-value < 0.001), Table 1.

Table 1 Demographic characteristics of the participants by nationality

Variable	Thai (n=2,941)	URAS* (n=181)	*P*-value	Test
Sex, n (%)			**0.955**	**Chi-square**
Female	1,550 (52.7)	95 (52.5)		
Male	1,391 (47.3)	86 (47.5)		
Median age, years (IQR)	**42 (31)**	**23 (27.3)**	**<0.001**	**Mann-Whitney U**
Age group (years), n (%)			**<0.001**	**Chi-square**
≤15	349 (11.9)	68 (37.6)		
>15–60	2,033 (69.1)	102 (56.3)		
>60	559 (19.0)	11 (6.1)		
Education			**<0.001**	**Chi-square**
Up to primary	981 (34.6)	115 (63.5)		
Secondary or above	1,856 (65.4)	66 (36.5)		
Median household income, US$ (IQR)	**938 (469–1,406)**	**188 (141–281)**	**<0.001**	**Mann-Whitney U**
Household monthly income, n (%)			**<0.001**	**Chi-square**
Above or equal average	2,080 (70.7)	30 (16.6)		
Below average	861 (29.3)	151 (83.4)		
Insurance status, n (%)			**<0.001**	**Fisher's exact**
Uninsured	6 (0.2)	177 (97.8)		
Insured	2,935 (99.8)	4 (2.2)		
Unmet healthcare need for OP care, n (%)			**<0.001**	**Chi-square**
Yes	61 (2.1)	98 (54.1)		
No	2,880 (97.9)	83 (45.9)		
Unmet healthcare need for IP care, n (%)			**<0.001**	**Chi-square**
Yes	61 (2.1)	49 (28.0)		
No	2,880 (97.9)	126 (72.0)		

**Urban refugee and asylum seekers. Missing data were excluded as they accounted for less than 1% of observations missing. IQR: interquartile range. OP: outpatient. IP: inpatient*

Determinants of Unmet Healthcare Need

The multivariable analysis indicated similar results for the factors associated with unmet healthcare need for both OP and IP care after adjusting for other potential covariates. Although being uninsured was linked to unmet healthcare need in univariable analysis, there was no significant statistical difference observed for OP care (AOR 4.4, 95% CI 0.7–29.7) and for IP care (AOR 2.8, 95% CI 0.3–27.5) in multivariable analysis. The strong association of experienced unmet healthcare need was being URAS (AOR 10.1, 95% CI 1.5–69.1) in OP care despite no significance found in IP care (AOR 5.0, 95% CI 0.5–50.3). The adjusted odds ratios between unmet healthcare need and being in the middle-aged group (>15 years but ≤60 years) were 1.9 (95% CI 1.0–3.4) for OP care and 1.4 (95% CI 0.7–2.6) for IP care. Gender and education backgrounds did not show statistical significance. In addition, URAS in less affluent households significantly faced greater degree of unmet healthcare need in OP care (AOR 1.9, 95% CI 1.2–2.9). This finding remained in the same direction in IP care despite having a marginal significance (AOR 1.6, 95% CI 1.0–2.5), Tables 2–3.

Table 2. Factors associated with unmet healthcare need for outpatient care by multivariable logistic regression

Variable	AOR	95% CI	*P*-value
Uninsured (vs insured)	4.4	0.7–29.7	0.126
Male (vs female)	0.9	0.6–1.4	0.785
URAS (vs Thai)	10.1	1.5–69.1	0.018
Age group (years) (vs ≤15)			
>15–60	1.9	1.0–3.4	0.046
>60	1.4	0.6–2.9	0.432
Education level (vs primary education)			
Secondary or above	0.7	0.5–1.1	0.165
Below-average economic level (vs equal or above average)	1.9	1.2–2.9	0.005

Missing data were excluded as they accounted for less than 1% of observations missing. URAS: urban refugee and asylum seekers. AOR: adjusted odds ratio. CI: confidence interval. vs: versus.

Table 3. Factors associated with unmet healthcare need for inpatient care by multivariate logistic regression

Variable	AOR	95% CI	*P*-value
Uninsured (vs insured)	2.8	0.3–27.5	0.387
Male (vs female)	0.9	0.6–1.3	0.574
URAS (vs Thai)	5.0	0.5–50.3	0.175
Age group (years) (vs ≤15)			
>15–60	1.4	0.7–2.6	0.348
>60	0.9	0.4–2.0	0.733
Education level (vs primary education)			
Secondary or above	0.7	0.5–1.2	0.208
Below-average economic level (vs equal or above average)	1.6	1.0–2.5	0.056

Missing data were excluded as they accounted for less than 1% of observations missing. URAS: urban refugee and asylum seekers. AOR: adjusted odds ratio. CI: confidence interval. vs: versus.

Mediation Analysis on Unmet Healthcare Need through Insurance Status

In OP care, the direct effect of URAS on unmet healthcare need displayed statistical significance (AOR 8.8, 95% CI 1.3–58.6). However, there was no statistical significance in the indirect effect (AOR 4.8, 95% CI 0.8–30.8). The odds of facing unmet healthcare need amongst URAS was about 40-fold the odds found amongst Thais, as presented by a large total effect with statistical significance (AOR 42.3, 95% CI 26.4–67.8), Table 4. Similar findings were found in IP care where the total effect demonstrated a large significant effect size (AOR 13.1, 95% CI 7.8–22.0), Table 5.

Table 4. Direct, indirect, and total effects of URAS (vs Thai) on unmet healthcare need for outpatient care (insurance status as mediator)

Type	AOR	95% CI	*P*-value
Direct effects	8.8	1.3–58.6	0.024
Indirect effects	4.8	0.8–30.8	0.099
Total effects	42.3	26.4–67.8	<0.001

AOR: adjusted odds ratio. CI: confidence interval.

Table 5. Direct, indirect, and total effects of URAS (vs Thai) on unmet healthcare need for inpatient care (insurance status as mediator)

Type	AOR	95% CI	*P*-value
Direct effects	4.5	0.5–43.8	0.198
Indirect effects	2.9	0.3–27.8	0.349
Total effects	13.1	7.8–22.0	<0.001

AOR: adjusted odds ratio. CI: confidence interval.

Prevalence of Unmet Need for Outpatient Care among URAS by Nationalities

Figure 2 and Figure 3 demonstrate the prevalence of unmet healthcare need for both types of services by URAS' nationalities. Palestinians and Iraqis had the highest levels of unmet healthcare need for OP care (100% both), followed by Afghans (85.7%) and Somalis (80.0%). Vietnamese reported the lowest unmet healthcare need prevalence (31.4%). Similarly, for IP care, Palestinians and Iraqis had the highest levels of unmet healthcare need (83.3% both). No Sri Lankan participants reported unmet healthcare need. Almost all participants experiencing unmet healthcare need cited a lack of financial resources as the main reason (for both OP and IP care, 96% and 94% respectively). Other reasons included language barriers and fear of law enforcement.

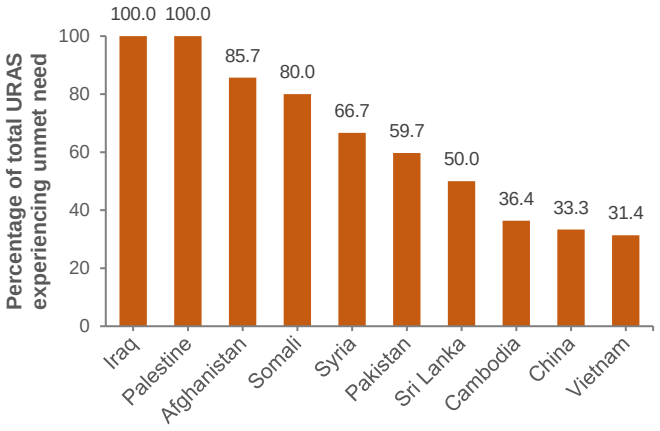


Figure 2. Prevalence of unmet healthcare need for outpatient care among URAS by nationalities (n= 2,941)

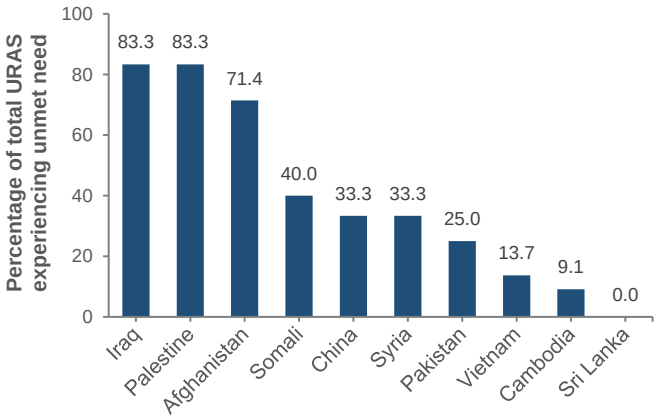


Figure 3. Prevalence of unmet healthcare need for inpatient care among URAS by nationalities (n= 2,941)

Discussion

This study is among a few studies in Thailand to investigate the degree of, and factors associated with unmet healthcare need amongst URAS. Demographic data showed that most URAS were relatively young and suffered from low household income. URAS had a

higher degree of unmet healthcare need, both for OP and IP care, compared to Thais, and the prevalence of OP unmet healthcare need was far greater than IP.

Multivariable logistic regression showed that being a URAS contributed to ten-fold greater odds of unmet healthcare need compared to being Thai. The result for IP care was expressed in the same pattern of OP care though with a lesser degree. Household economic status was significantly related to both OP and IP unmet healthcare needs.

Mediation analysis showed that the contribution of URAS status to unmet healthcare need was not fully mediated via insurance status, although the insurance status itself still played a pivotal role towards unmet healthcare need. URAS originating from the Middle East encountered a greater degree of unmet healthcare need compared to URAS from Southeast Asia. Financial constraints were the primary reason for unmet healthcare needs among individuals seeking treatment.

In Thailand, no official public health program supports healthcare need for URAS. UNHCR and NGOs provide interpretation services with small monetary support for living expense and serious health conditions requiring hospital admission for URAS.[27] This means URAS may need to manage for themselves when OP care is needed, while for IP care for serious illnesses, there are some existing supporting mechanisms from UNHCR and NGOs (though not comprehensive).[28]

Though the effect of being URAS mediated by a lack of insurance on unmet healthcare need (indirect effect) did not show a statistical significance, a significantly large total effect was observed. This implies that unmet healthcare need among URAS might be alleviated if more URAS could be insured. Hence, enrolling URAS in public insurance schemes should be considered, as insurance provision depends on health system design, whereas nationality is an immutable factor.[29,30]

This study's findings align with previous literature.[21,29–31] A study of Syrian refugees in Turkey by Torun et al, reported that Syrian refugees experienced many key barriers in accessing healthcare such as language disparities and limited knowledge in the Turkish healthcare system.[29] Studies by Ying Liew et al, and Khanom et al, underpinned the impact of low socioeconomic status that hinders access to healthcare among URAS in Malaysia and the United Kingdom.[21,31]

There are some policy implications from this study's findings. First, since the unmet healthcare need for OP care was more profound than for IP care, innovative healthcare programs which focus on minor illnesses should not be neglected (such as mobile clinics and community health centres). These initiatives necessitate seamless collaboration between numerous parties, including MOPH and UNHCR.

Second, as language barrier was mentioned by URAS in this study and in various literature, interpretation services should be strengthened to bridge communication gaps.[32] The Thai MOPH has implemented 'migrant health volunteer' program by recruiting bilingual migrants to work closely with health personnel.[33,34] Therefore, the expansion of the migrant health volunteer program to encompass URAS would be valuable.

Finally, though URAS status serves as the most influential factor affecting unmet healthcare need, it is extremely difficult to be modified (if not, impossible). There are some less influential factors that can be addressed, such as insurance status or household economic level. Though these factors did not exhibit significant association with unmet healthcare need, policies to address these issues are of huge merit. Initiatives to avoid healthcare impoverishment and uplift the economic status of URAS should be examined.[35,36]

Some limitations remain in this study. First, the survey was performed at the BRC office in order to protect sensitive information of URAS, namely the participants' address. Consequently, some other crucial household information, including household assets and owners' equity could not be obtained. Besides, this study did not fully trace the participants' disease profile. Future studies could incorporate physical visits for data collection and explore more on the participants' health status.[37]

Second, although phone calls were executed as an attempt to boost the representation of individuals with travel difficulty, this study could not fully reach those who did not show up at the BRC office. Future studies should delve down into the healthcare need of hard-to-reach URAS.[38,39]

Last but not least, as the nature of the survey was retrospective, memory bias is inevitable. Therefore, a continuous monitoring on health status, degree of healthcare access, and quality of life of URAS should be implemented.

Conclusion

URAS in Thailand reported high prevalence of unmet healthcare need (54.1% for OP care and 28.0% for IP care). This prevalence was also markedly higher than the prevalence of Thais. The most important reason for unmet healthcare need reported by URAS was the lack

of financial resources to afford treatment. Being URAS and low household income exhibited significant association with unmet healthcare need for OP care. Mediation analysis showed a large total effect on the association between URAS and unmet healthcare need by using a lack of insurance as the mediator. Multi-faceted policies to reduce barriers towards healthcare access amongst URAS should be introduced.

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Conflicts of Interest

The authors declare non-financial competing interests.

Author's Contribution

YP, RA, ST, and HK conceptualized the study. YP, RA, and HK curated data and conducted the formal analysis. HK acquired funding and provided resources. Methodology was handled by YP, RA, and HK. YP, RA, and ST managed the project. YP, RA, and HK conducted the investigation and developed the software. HK supervised the study. Validation was done by YP, RA, and HK. Visualization was managed by YP and RA. YP, RA, and ST drafted the manuscript. All authors read and approved the final version.

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Narrative Review on Universal Health Coverage in Thailand and China from the Lens of Social Determinants of Health Theory

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Abstract

This article through the literature review method briefly compares universal health coverage (UHC) in Thailand and China, highlighting their strategies and challenges in achieving UHC through the lens of social determinants of health: a) health financing design and sustainability, b) accessibility of healthcare resources, and c) participatory and responsive governance. While Thailand mainly utilizes a tax-based approach, China employs a health insurance model. Both countries have achieved high insurance coverage. However, some challenges exist. The unmet need for health services due to long waiting times has been a key concern in Thailand, whereas financial hardship from receiving care was a critical concern in the case of China. Thailand has created a mechanism to allow a wide range of stakeholders to participate in the UHC design to ensure responsive governance. In contrast, China has not yet formed comprehensive legal grounds for participatory and responsive governance on UHC. Their experiences and encountered obstacles can offer valuable lessons on how middle-income nations can advance towards UHC, highlighting the critical need for ongoing improvements in health systems to tackle the existing and new health challenges due to the change in population demographics and the continuing increase of population healthcare demand.

Keywords: universal health coverage, social determinants of health theory, Thailand, China

Introduction

Universal health coverage (UHC), as one of the sustainable development goals 3.8, is critical for ensuring that all individuals are able to access necessary health services without facing financial hardships.[1] In middle-income countries, the achievement of UHC is confronted with distinctive challenges such as issues related to financing mechanisms, unequal distribution of healthcare resources, and the prevalence of informal economic activities.[2] Nonetheless, through effective policy formulation and innovative financing strategies, some countries can surmount the obstacles and gradually progress toward UHC. Thailand and China are among the successful cases despite many challenges remain, showing that middle-income countries can make positive effort towards UHC.[3,4]

Thailand achieved UHC with the introduction of the Universal Coverage Scheme (UCS) in 2002. Before the UCS, Thailand implemented the Civil Service Medical Benefits Scheme in 1980 and the Social Security Scheme in 1990. These three basic schemes covered 98.5% of the population in 2015 (Table 1).[5] In contrast, China's process of achieving UHC has been more gradual, beginning with a series of reforms in the late 1990s and early 2000s, with the implementation of Urban Employee Basic Medical Insurance in 1998 and Resident Basic Medical Insurance in 2007 which cover 75% of the population (Table 2).[6] Subsequently in 2018, UHC had been achieved, with the insurance coverage remaining over 95% annually.[7]

Table 1. Key characteristics of the basic health insurance schemes in Thailand[8,9]

	Universal Coverage Scheme (2002)	Social Security Scheme (1990)	Civil Servant Medical Benefit Scheme (1980)
Beneficiaries	Thai citizen	The employed in the private sector	Government employees and dependents
Premium	Tax-based financing	A fixed percentage of the employee's salary (varies, typically around 5%, maximum $21)	Tax-based financing
Funding source	Government budget	Contributions (employee, employer, government)	Government budget
Length	Lifetime	As long as employed and contributing	Lifetime for employees; vary for dependents
Benefit	A broad range of services including outpatient and inpatient care, preventive, promotive, curative, rehabilitative, emergency services, other high-cost care, etc.*		

**Few medicines or operation lists may differ across schemes*

Table 2. Key characteristics of the basic health insurance schemes in China[10,11]

	Urban Employee Basic Medical Insurance (1998)	Resident Basic Medical Insurance (2007)
Beneficiaries	Employees	Non-working residents (children, students, elderly, self-employed, and others)
Premium	Employee (2%) and employer (8%) payroll	Individual ($53), government subsidy ($94)
Funding source	Contributions (employee, employer, government)	Individual premium, government budget
Length	Men pay 25 years, women 20 years; lifetime benefits after retirement	Pay for one year, insured for one year
Benefit	≈85% reimbursement	≈70% reimbursement

Although Thailand and China have both achieved UHC, the models are different. Thailand primarily operates the national health insurance model, which is predominantly tax-based. China is chiefly the social health insurance model, proportionally contributed by citizens, employers, and the government. The reimbursement standards in China are relatively complex with varying reimbursement ratios depending on the type of insurance, the level of the hospital, and the provinces.[12] Figure 1 is an example of this complexity. The annual out-of-pocket expenses in the designated healthcare facilities that exceed the reimbursement threshold and within the cap limit are reimbursed according to specific rates that vary by province. In cases of catastrophic illness, annual expenses that surpass the cap limit can apply for secondary reimbursement, which is approximately 60% without a cap limit.

There have been numerous comparative studies on UHC, although the comparative research focusing on Thailand and China has been relatively scarce. The cases of Thailand and China demonstrate how developing countries can reach UHC through effective policy design and implementation with limited resources. Moreover, although there are differences in political systems and governance structures between the two countries, both UHCs are driven by strong governmental initiatives.

This study therefore aimed to understand and evaluate the strategies and challenges in achieving UHC in Thailand and China through the lens of social determinants of health theory. By comparing the UHC in the two countries, it could reveal how different government structures influence UHC, which can provide insights into global health governance and the achievement of sustainable development goals.

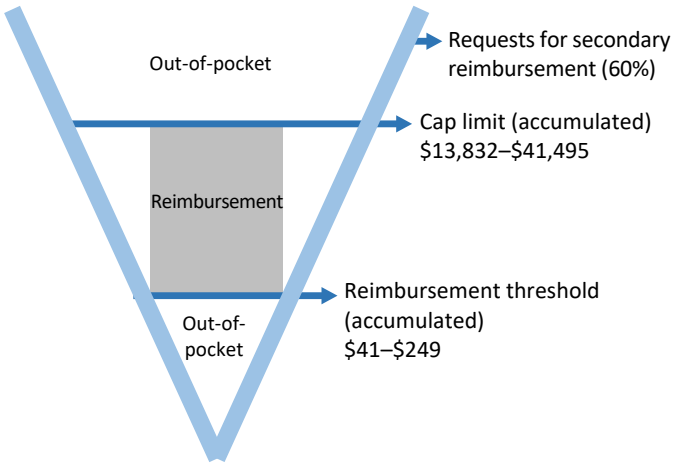

Figure 1. Reimbursement criteria of the basic health insurance schemes in China, 2024[13]

Methods

This study used a narrative review approach. The article search was done between 28 Jan to 13 Apr 2024 and the most recent update was on 16 Jun 2024. The sources of literature included peer-reviewed articles, and documents in PubMed and China National Knowledge Infrastructure (CNKI) databases published before January 2024. The inclusion criteria were: a) articles containing information about UHC in Thailand and/or China; b) articles on UHC in Thailand published between 2002 and 2024 in English; and articles on UHC in China published between 2018 and 2024 in either English or Chinese. Note that, for the Thai UHC, this study focused on the UCS—the main public insurance arrangement that covers the majority of the Thai population. The years 2002 and 2018 were chosen as the baseline for the literature search based on the timing of the implementation of UCS in Thailand and the achievement of UHC in China. Exclusion criteria were: a) documents not related to UHC in Thailand and/or China; b) documents not in English or Chinese. The Boolean operator 'OR' was used to combine various conceptual terms of "universal health coverage [Title/Abstract])" and subsequently the Boolean operator 'AND' was used to combine the results of the UHC search with "Thailand" and/or "China". This study descriptively analyzed the contents of the selected articles based on the following aspects: a) health financing design and sustainability, b) accessibility of healthcare resources, and c) participatory and responsive governance.

Results

A total of 814 articles were retrieved. From the perspective of social determinants of health, 22 studies met the inclusion criteria. These studies explored UHC in Thailand (n=12) and China (n=10). Among these, 20 papers were in English and 2 were in Chinese (Figure 2).

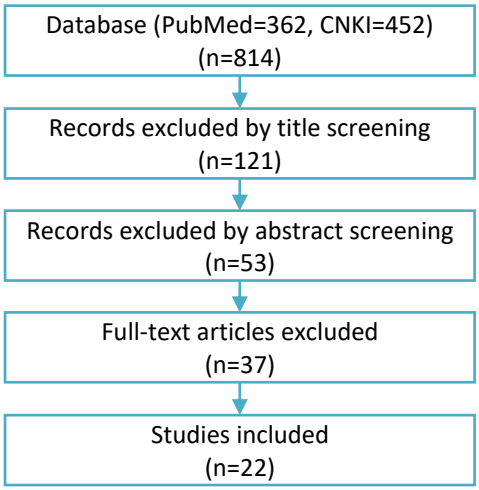

Figure 2. Flow diagram of article selection

Health Financing Design and Sustainability

From the financing mechanism perspective, UCS primarily utilizes a tax-based financing model. The Thai government's domestic health spending, strong political commitment, and the historical precedence of tax-funded health benefit programs were key to implementing UCS, which ensures adequate resources, increases transparency, and limits discretionary decisions in budget allocation.[3] Conversely, the implementation of Residents Basic Medical Insurance in China places greater emphasis on a social medical insurance system with sharing medical expenses through a diversified source of funds.[14] Considering China's vast and diverse population base, as well as the reality of uneven economic development, this mechanism attempts to meet the needs of different groups through various insurance plans.[15]

In terms of the mode of provider payment, China used to employ the fee-for-service which directly linked the number of medical services to the income of medical institutions and physicians, which might have led to overtreatment elevating the expenditure and out-of-pocket cost.[16] However, insufficient monitoring had complicated the fee-for-service design in previous years.[17] To tackle the issue, the recent healthcare reform has shifted the payment method to diagnosis-related groups, motivating more efficient and reasonable medical services.[14] Also, drug collective procurement policy has been applied to control the expenditure.[18,19]

The payment method is relatively mature in Thailand compared to China. Thailand mainly employs the annual age-adjusted capitation payment system and drug collective procurement was implemented early on. It is one of the key policy instruments for Thailand to demonstrate favorable results in UCS.[20] Therefore, well-designed strategic purchasing contributes to efficiency, cost control, and equity.[21]

Accessibility of Healthcare Resources

Both China and Thailand have largely achieved high insurance coverage, which addresses "all individuals" in the definition of UHC. However, this does not mean all individuals can access healthcare without barriers. Thailand's annual prevalence of unmet healthcare needs remained below 3% with a high overall consumer satisfaction.[22,23] In contrast, in China, the incidence of unmet outpatient and inpatient needs due to economic barriers stood at about 5% and 19%, respectively.[24] Compared to Thailand, especially for inpatients, the unmet needs in China are higher, despite the current results being much better than before.[25]

The causes of unmet needs differ significantly. In Thailand, the primary reasons are long waiting times and distance to healthcare facilities, and the cost of treatment is not a significant barrier and is less of a barrier than that posed by geographic barriers.[26,27] The UCS has reduced average out-of-pocket expenses by 28%, and is credited for the significant reduction in catastrophic health expenditure and impoverishment rates.[28,29] In China, the most common reasons for unmet needs are insufficient money and the perception that treatment is unnecessary due to the non-severity of the condition, indicating that economic factors are still predominant.[30] Thus, more efforts need to be invested to meet the ultimate goal of UHC.[31]

Participatory and Responsive Governance

Participatory and responsive governance is essential for UHC, ensuring responsiveness to public needs and improved quality of healthcare services through inclusive decision-making.[32] In Thailand, citizen participation is explicitly institutionalized in the UCS, with 23 legislative sections for participatory governance and 18 sections for responsive governance. For example, Thai law requires that representatives from civil society or non-governmental organizations must be included in the UCS management committee to ensure that public views and interests are reflected and taken into account. Moreover, public access to information on program governance is ensured through public information and information dissemination systems to increase transparency and responsiveness to the public.[33]

China has not yet formed a comprehensive and systematic legal system for the health insurance system. The descriptions of participatory and responsive governance about UHC are scattered in different laws, regulations, and policies without specifically identifying the actionable rights and modalities.[34,35] In China, civil society, other parties, and non-governmental organizations participate in health reform, policy decision-making, and monitoring through the National Committee of the Chinese People's Political Consultative Conference.[36] Citizen participation is usually achieved through public consultation and collection of opinions.[35] The mass media have been generally active and participatory in the new healthcare reform, and have played an important role in expanding citizen policy participation.[37] Regarding responsive governance, the government opened internet platforms to extensively solicit public opinions in this healthcare reform, receiving over 30,000 feedback and suggestions, but how these feedback and suggestions were integrated into the new regulation and policy was not disclosed.[38]

Discussion

Thailand and China have some experiences worth learning for achieving UHC, as well as some challenges that need attention.

Thailand's experience in achieving UHC is primarily reflected in the following aspects. First, Thailand has continuously expanded the volume of the health workforce before and during the UHC era. The collaborative projects to increase the production of rural doctors and the one district one doctor programs are examples of health workforce policies which enhance medical service capabilities in remote and rural areas.[39] These policies also involve prioritizing primary healthcare as the core of UHC and promoting primary care units to shift medical services from hospitals to community-based settings to enhance the accessibility and quality of primary healthcare services.[40,41]

Second, Thailand's experience has demonstrated the effectiveness of cross-sectoral collaboration, like the Collaborative Projects to Increase the Production of Rural Doctors and One District One Doctor are jointly managed by the Ministry of Public Health and the Ministry of Education.[39] Consultative meetings that involved policymakers, administrators, and health practitioners to discuss the mismatch between medical service demand and supply were conducted.[41]

Last, strong political commitment and active participation of health personnel were key to Thailand's successful implementation of UHC.[42] Since 2001, the Thai government has provided ongoing policy support and financial investment for health system reform, which has been crucial for expanding coverage of basic medical services.[40] The active participation of social organizations has played a significant role in advocating for health policies and reforms, facilitating broader social acceptance and participation.[42]

For China, first, its experience in achieving UHC is primarily characterized by strong political commitment and policy implementation, which is like the Thai case. The clear political will to achieve UHC is one of the most crucial prerequisites.[43] The government's political commitment and effective policy implementation ensure that health reforms continue to progress and effectively respond to needs.[44,45] Additionally, strong government intervention and funding are key to achieving a high coverage rate.[12,43,46]

Second, primary healthcare is a central and crucial step in advancing UHC.[43,45] China has enhanced the accessibility and affordability of medical services by increasing investments from both the government and the private sector, expanding the service capacity of

grassroots medical institutions, and improving the quality of primary healthcare services.[43,44,46] Simultaneously, there has been extensive application of information technology in medical management and service provision to enhance the efficiency and level of medical services.[45]

Last, health policies have been integrated with other social policies to address complex social health issues such as poverty alleviation and strategies to address an aging society.[45] China does not solely focus on individual sectors but also promotes a dynamic balance among medical services, health insurance, and pharmaceuticals which help to build a coordinated healthcare system.[43] Moreover, China has implemented a series of policies to achieve UHC since 2005, and the healthcare reform has been ongoing, highlighting the importance of maintaining policy coherence and continuity throughout the transformation of the healthcare system.[12,45]

However, achieving UHC is a long-term journey and challenges remain. One of the challenges Thailand faces is the burden of non-communicable diseases (NCDs), which has emerged as a longstanding challenge for the country, and families may face catastrophic health expenditures due to the costs of treatment.[42] Another challenge is the pressure of aging, compounded by the increasing burden of NCDs, which poses significant concern on Thailand's fiscal sustainability.[42] This challenge necessitates a shift in the healthcare model from hospital-centered care to non-hospital settings and to create a platform that provides better facilitates the integration of all levels of medical services.[41,42] The dire need to improve the quality of healthcare services, particularly in disease prevention and health promotion, is also an ongoing challenge for Thailand's primary healthcare.[40] Despite, a large number of medical professionals produced each year, Thailand still experiences mismatches between the increasing population health needs and the number of workforce available, let alone the challenge in ensuring quality and consistency of training programs across regions.[39–41] Inequitable workforce distribution and how to attract and maintain health professionals in rural public services is of significant concern.[39]

Some challenges China UHC is facing include, first, the financial hardship incurring on the insurance beneficiaries.[12] This problem is more severe in the management of NCDs and among low-income individuals.[44,46] Although the out-of-pocket proportion of medical expenses has decreased, the risk of impoverishment and relapse into poverty due to illness still exists.[45]

Second, significant disparities still exist in service provision, quality, and equity between regions.[12,43–45] Although the coverage of healthcare services has expanded, service quality, especially in the management of NCDs, still needs improvement.[45] Since China's healthcare system is highly dependent on hospitals, services are primarily treatment-oriented and lacking sufficient preventive and primary care measures.[46]

Last, despite the vision of Healthy China 2030, the coordination between sectors such as health, development, transportation, and education, is inadequate in actual policy implementation, affecting the execution of comprehensive health policies.[46] In the process of healthcare reform, public participation and voices are still insufficient. It is necessary to further strengthen mechanisms for public involvement in policy-making.[43]

This study has some limitations. The use of narrative review, despite being applicable to the study objective, means the review is subject to selection bias compared to systematic review or meta-analysis, which are mostly employed when the review objective is more focused. Besides, as UHC depends on health system design which is subject to change according to policy fluctuations, the challenges and successes identified in this study are not time-invariant. Thus, the readership should interpret the results with caution, while taking into account differences in the political context between the two countries.

Conclusion

Thailand has utilized a tax-based financing model, while China has implemented a mixed financing approach to progressively advance its UHC. Although both countries have achieved high coverage rates, they continue to face challenges in ensuring financial sustainability, equitable distribution of resources, and accessibility to healthcare services. Particularly in China, reforms in payment methods, centralized drug procurement policies, and the establishment of a tiered diagnosis and treatment system have been critical for more effectively control of medical costs and enhance the efficiency of healthcare services.

The realization of UHC extends beyond merely establishing a medical service framework. It encompasses efforts to improve the accessibility and affordability of healthcare services, elevate the quality of care, and enhance the financial sustainability of health systems. Consequently, even nations that profess to have achieved UHC should continuously refine and adjust their healthcare systems to address emerging health challenges and the evolving health needs of their populations.

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Conflict of Interest

No conflicts of interest are associated with the material presented in this paper.

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The Grammar of Science: Good Design of Data Collection Form—a Must-do

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Data Acquisition Tool and Data Quality

One of the must-do tasks in the early phase of study planning is designing a data acquisition tool. In most cases, a data collection form (DCF) is used. DCF is designed to systematically gather specific information related to research questions and objectives. It is a tool that helps gather data in an organized and efficient manner through predefined fields or questions.[1] In clinical research, DCF is usually called "Case Record/Report Form" (CRF).[2,3] DCF format varies due to the complexity and purpose of the study. Various types of DCF can be designed to collect primary or secondary data, and quantitative or qualitative data.[1] The primary data collection form is designed to gather original data directly from sources via surveys, interviews, and observational checklists. The secondary data collection form is typically designed to extract data from existing sources including databases, reports, or previous studies. Quantitative DCF collects numerical data which could be categorical data (e.g., diabetes (Y/N), duration of exposure (1–3 months, 4–6 months, >6 months)) or continuous data (e.g., age, quality of life score). Qualitative DCF is a note-taking template that transcribes non-numerical data from in-depth interviews or focus-group discussions.[1]

Data quality is critical. A famous old expression in computer science says "Garbage In, Garbage Out." Poor-quality data can lead to poor decision-making within the research study.[4] Poor data quality can lead to the inability to answer research questions, distort findings, waste resources, misleading conclusions and recommendations, and may even do harm to study participants.[5,6] Poor data quality includes, but not limited to, the followings: data entry errors, incomplete data sets, and outdated information. According to the European Medicines Agency, a good clinical practice (GCP) covers ethical and scientific quality standards for designing, recording, and reporting studies that involve human subjects. The content within the GCP guideline is not actually limited to clinical aspects. Thus, GCP has been used by all ethics committees when reviewing research protocol. Two major issues in GCP are protecting the rights, safety and well-being of study participants and the credibility of the study data.[7] According to GCP, the researcher should ensure the accuracy, completeness, legibility, and timeliness of the data in the data acquisition tools.[8] It is quite a challenge for form designers to secure and ensure data quality captured on DCF—how to make it easy to use, understand, complete, and accurate.

DCF Design Process

DCF can be in paper form (pDCF) or electronic form (eDCF). Each type has its own advantages and drawbacks regarding data management and data quality.[2,3,9] pDCF may result in data errors when transferring or transcribing the data onto the computer system. Particularly for eDCF, edit checks are generally programmed into the data collection system to help ensure data integrity and improve data quality by immediately checking the entering data in terms of expected range, inconsistency, illogical, or discrepancy. However, eDCF may have limitations when lack of available on-site technology, complexity of installation, and maintenance of the software, and high investment cost.[2] Recently, the so-called "patient-reported outcomes (PRO)" is quite common in clinical research. PRO is the DCF that the data is directly reported by study participants. As an example of PRO, study participants may be asked to record on a daily diary card (booklet) regarding their signs and symptoms, and their own subjective experiences of pain intensity or quality of life using rating scales and questionnaires. Because these data are recorded by

study participants themselves rather than trained data collectors, the PRO should be well-designed by taking into consideration of study participants' characteristics and perspectives.

It is said in the literature that the number one neglected topic in statistics is measurement.[10] When you don't think seriously about measurement, bad things could happen.[10] Thus, DCF should be designed by following the study procedures and data flow from the perspective of the person completing it.[2,4,9] The best practice in designing DCF is using a multidisciplinary team design (including data entry personnel, biostatisticians, and the internal study team) to provide input into the DCF to ensure the data collected meet the needs of the study from all pertinent perspectives.[9]

The very first step in designing DCF is that you need to have a clear idea of what information you need to collect and who are your targeted population. DCF should capture protocol-required information but should not record data that ultimately will not be used for analysis or will not support analyzed data.[8,9] That means you have to understand your research questions and objectives, and the characteristics of the study participants. This will define the scope, content, and format of your DCF.[11] It is important to always have operational definitions of key variables to be used in data analysis (Figure 1).[4] Data gathered should be based on the underlying terminology or the operational definition of the variables needed to answer your research questions.[10]

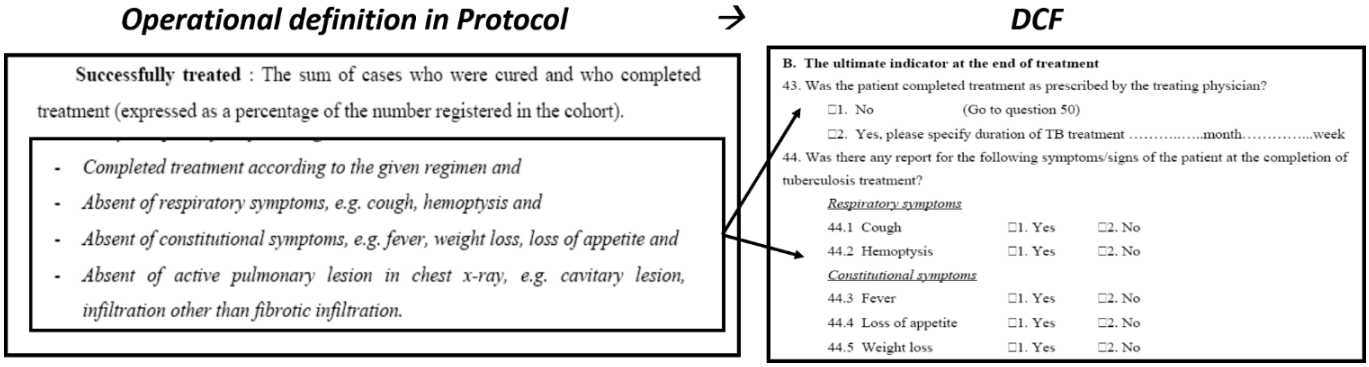


Figure 1. DCF collects "successfully treated" for TB patients according to the study definition

Good DCF should contain an informative header and footer including protocol ID, site code, and subject ID, version number, and page number.[2,3,9] Prior to finalizing the DCF, you should perform pre-testing with a sample of the targeted population. In the development process, you then may have many versions of DCF, and you should keep track of version control (Figure 2).

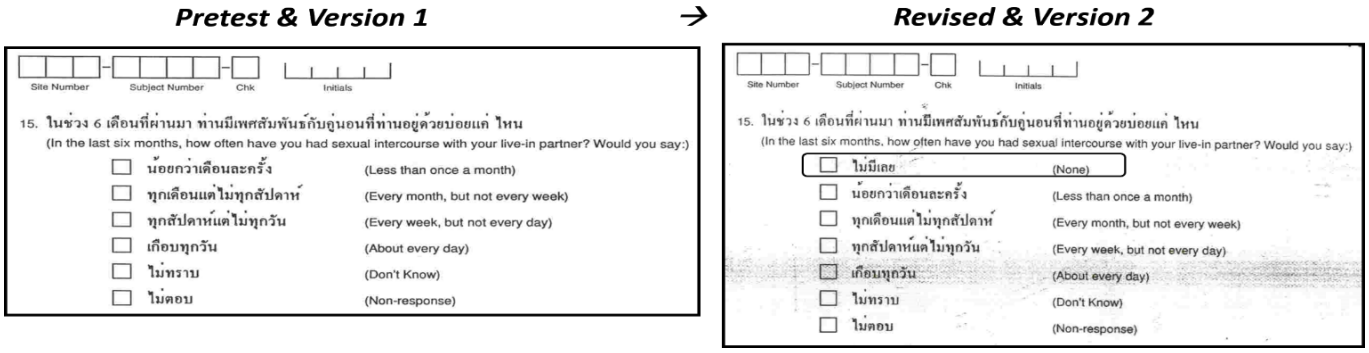
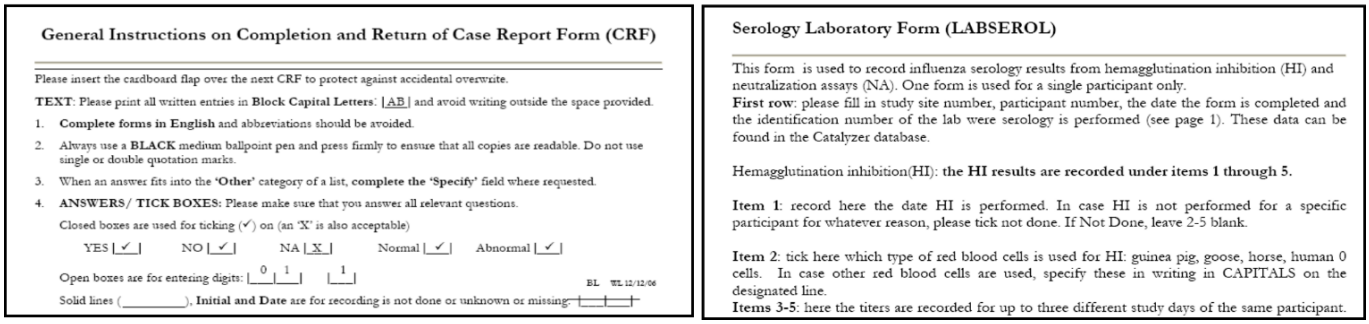


Figure 2. Original version and revised version of DCF with additional choice

One of the most important aspects of DCF design is to provide clear and helpful instructions in filling out the form.[11] To help ensure data quality, there should be a DCF completion guideline (Figure 3). The guideline is also useful for training data collectors. The guideline should contain how to fill out items in each part of the DCF with an explanation of the descriptions or operational definitions of certain protocol-specific items.

DCF Completion Guideline / Manual



General Instructions on Completion and Return of Case Report Form (CRF)

Please insert the cardboard flap over the next CRF to protect against accidental overwrite.

TEXT: Please print all written entries in **Block Capital Letters**: |AB| and avoid writing outside the space provided.

1. **Complete forms in English** and abbreviations should be avoided.
2. Always use a **BLACK** medium ballpoint pen and press firmly to ensure that all copies are readable. Do not use single or double quotation marks.
3. When an answer fits into the **'Other'** category of a list, **complete the 'Specify'** field where requested.
4. **ANSWERS/ TICK BOXES:** Please make sure that you answer all relevant questions.

Closed boxes are used for ticking (✓) on (an 'X' is also acceptable)

YES |✓| NO |✓| NA |X| Normal |✓| Abnormal |✓|

Open boxes are for entering digits: |0|1| |1|

Solid lines (_____), **Initial and Date** are for recording is not done or unknown or missing: |__|__|

BL WL 12/12/06

Serology Laboratory Form (LABSEROL)

This form is used to record influenza serology results from hemagglutination inhibition (HI) and neutralization assays (NA). One form is used for a single participant only.

First row: please fill in study site number, participant number, the date the form is completed and the identification number of the lab were serology is performed (see page 1). These data can be found in the Catalyzer database.

Hemagglutination inhibition(HI): **the HI results are recorded under items 1 through 5.**

Item 1: record here the date HI is performed. In case HI is not performed for a specific participant for whatever reason, please tick not done. If Not Done, leave 2-5 blank.

Item 2: tick here which type of red blood cells is used for HI: guinea pig, goose, horse, human 0 cells. In case other red blood cells are used, specify these in writing in CAPITALS on the designated line.

Items 3-5: here the titers are recorded for up to three different study days of the same participant.

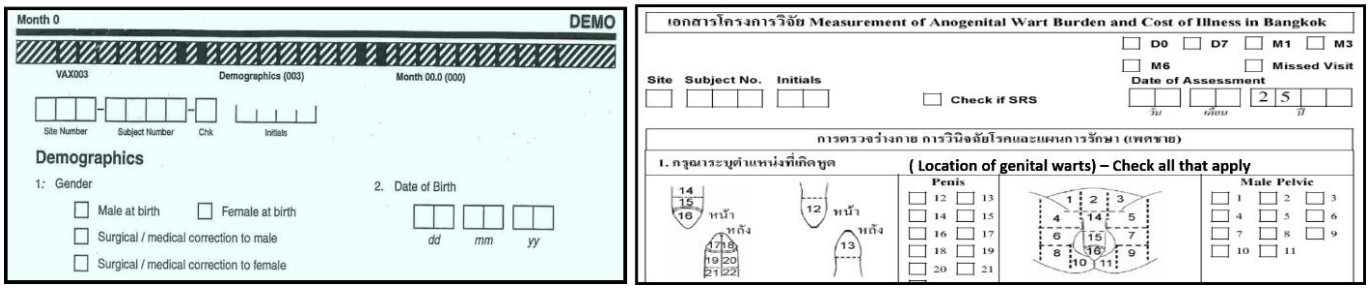
Figure 3. General and DCF-specific data completion guidelines

Standards and Good Practices in DCF Design

Designing a DCF is both science and art. DCF should include sufficient and accurate data to reach research objectives during analysis. On the other hand, the DCF should be presented in a format to enhance easy reading/understanding and accurate data entry.[2,9] Here are some tips and tricks in DCF design.[2,5,8,9,11]

- *Design in Accordance with the Study Protocol Compliance.* The collection of unneeded data will result in wasted resources in collecting and processing and not even being utilized for analysis.[2,9]
- *Do not Collect Personal Identifiable Information (PII) on DCF.* According to the GCP guideline and certain legal regulations on the confidentiality of personal information, you must not have identifiable information on DCF.[8] However, if PII is needed to be collected in some circumstances (such as during outbreak investigation, not in general research context), investigators must maintain its confidentiality as best as they can. In clinical research, you may collect PII (e.g., personal ID) to avoid duplicate enrollment (advertently or inadvertently) or to link with medical records of the study participants; such PII must be kept in a confidential DCF package, separate from the DCF package used to answer research questions.
- *Choose the Right Type and Number of Questions.* Data to be collected to answer your research questions will affect the quantity and quality of the data on DCF. Avoid asking too many or too few questions, as this can lead to respondent fatigue, boredom, or confusion.[11] Types of data will dictate the types of questions on DCF. Several types include, for example, open-ended, closed-ended, multiple choice, or rating scale (Figure 4-6). To make it easier for data management and analysis as well as achieving standardized answers across study sites, try to use close-ended questions with a coded format (fixed choices) whenever possible. The use of pictorial choices may be helpful for a certain issue (Figure 7). Avoid (open-ended) free text questions.[2,3,4,9]

Close-ended Question (Fixed choice) ***Close-ended Question (Check all that apply)***



Month 0 DEMO

VAX003 Demographics (003) Month 00.0 (000)

Site Number Subject Number Chk Initials

Demographics

1: Gender

Male at birth Female at birth

Surgical / medical correction to male

Surgical / medical correction to female

2. Date of Birth

dd mm yy

เอกสารโครงการวิจัย Measurement of Anogenital Wart Burden and Cost of Illness in Bangkok

D0 D7 M1 M3 M6 Missed Visit

Site Subject No. Initials Check if SRS Date of Assessment

การตรวจร่างกาย การวินิจฉัยโรคและแผนการรักษา (เพศชาย)

1. กรุณาระบุตำแหน่งที่เกิดหูด (Location of genital warts) – Check all that apply

Penis Male Pelvic

Figure 4. Examples of close-ended questions

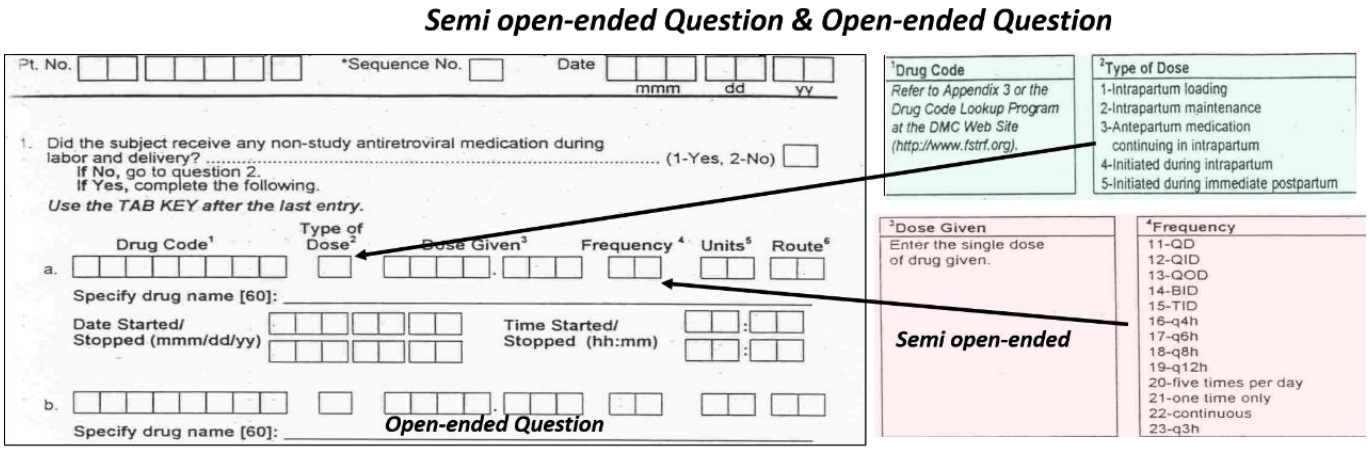


Figure 5. Examples of semi open-ended and open-ended questions

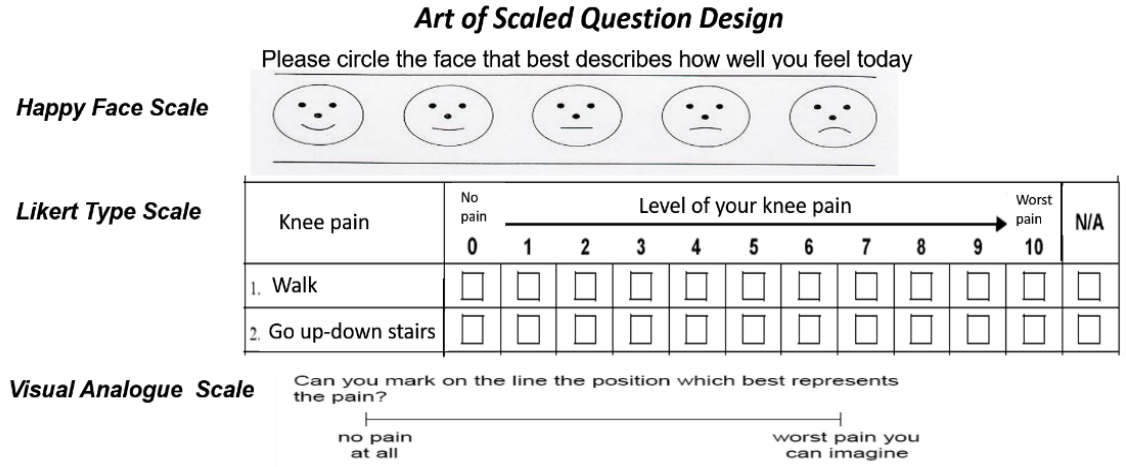


Figure 6. Examples of scaled questions

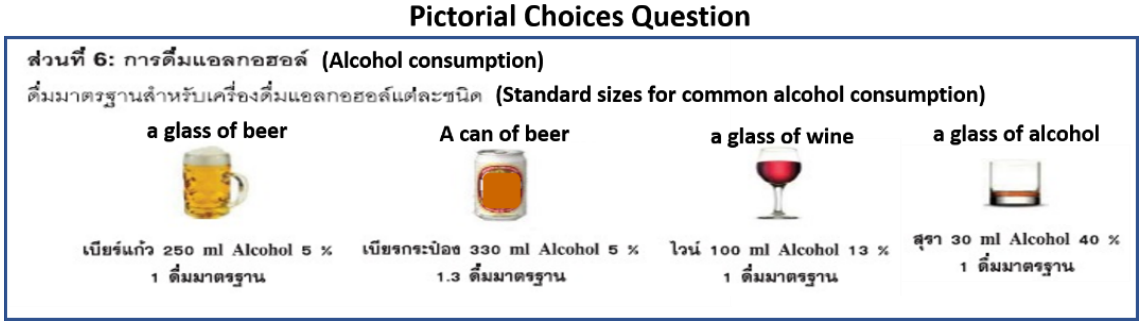


Figure 7. Examples of pictorial choices questions

- *Layout of Data Fields Arranged in a Clear, Logically Formatted, and Easy to Follow.* Complicated forms can lead to nonresponse or careless response.[5] Problems with data quality for pDCF are related to the poorly designed, organized, or printed of the DCF. It is recommended that DCF should be printed single-sided with legible font size. DCF page should contain both the page number and the total number of pages. [9]
- *Use Simple and Clear Language.* Language comprehension can be a barrier.[5] To ensure obtaining complete and comparable data, wordings should be clear, simple, concise, specific, and consistent while avoiding jargon, technical terms, acronyms, or abbreviations that your respondents may not understand.[9,11]
- *Avoid Collecting Duplicate Data.* The presence of redundant data is a very common problem in many studies.[3] Duplicates can result from collecting identical information (e.g., age and date of birth) from different sources, or from human error.[4] Try not to collect redundancy data as it will create unnecessary work for data collectors and the need to check for consistency between redundant data points.

- *Avoid Referential Questions with a Skipping Pattern* (Figure 8). Answering a question upon the answer to another question creates a high chance of having missing or incomplete data.

Referential Questions (Skip Pattern)

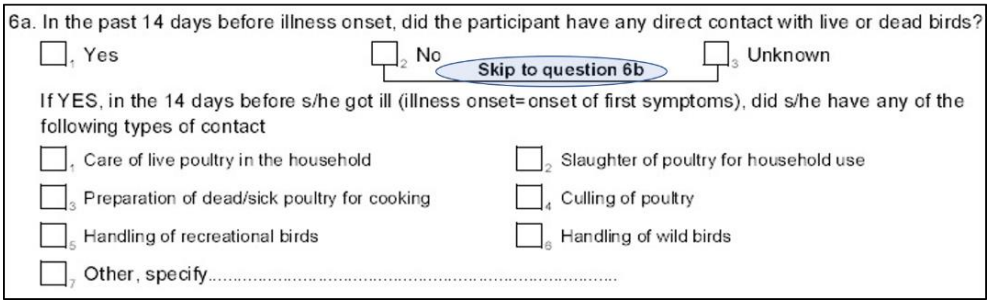


Figure 8. Examples of referential questions

- *Provide Units of Measurement for Data Fields.* If data is stored in inconsistent formats, the information may not be comparable and interpreted correctly. It is a good idea to provide units of measurement (Figure 9), particularly in multi-site study. As an example, local laboratories may use different units of measurement, thus asking the data collectors to keep the original value and its unit. Unit conversion can be done during the data analysis phase, not during the collection phase.

Fixed vs. Open Lab Units

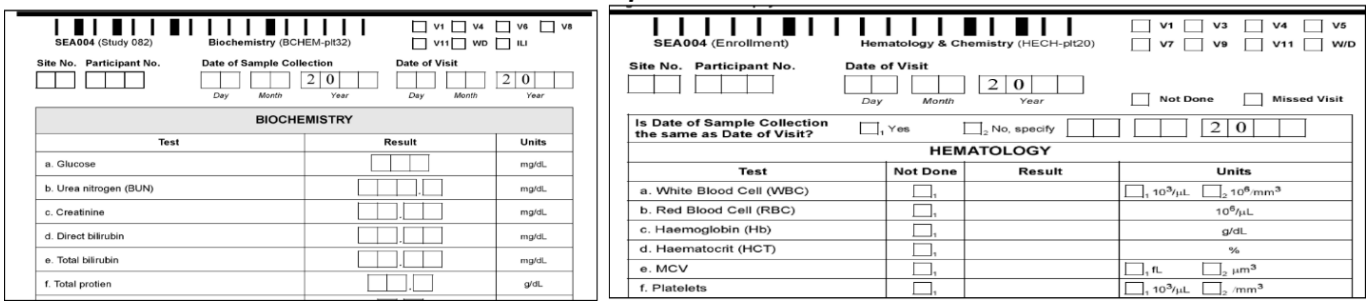


Figure 9. Examples of fixed and open lab units

- *Do not Ask the Data Collector to Perform any Calculation on DCF.* Errors could occur when asking the data collector to calculate or derive a data value for other raw data values (e.g., asking to calculate BMI from weight and height).[9] Let it be the work done in the data management or data analysis phase.
- *Arrange a Package of Series of DCFs over the Study Period.* When data are collected over the course of a longitudinal study, DCFs for each study participant should be sequentially arranged in order according to timelines (visits) and separated by sections (Figure 10).[3,9]

Schedule for data (DCF) collection

WEEKS →	4	8	12	16	20	24	32	40	48	52
CES Depression Scale Scoring	V	V		V		V	V		V	V
Profile of Mood States Scoring	V	V		V		V	V		V	V
Auditory Verbal Learning Test - Revised		V		V		V			V	
Play Performance Scales		V		V		V			V	

Figure 10. Schedule of data collection using series of DCFs

Conclusion

Valid and credible data is important to reach accurate research results. The measurement errors could lead to incorrect statistically significant findings.[12] Data on DCF should be organized in a format that facilitates and simplifies data analysis.[2] According to Good Clinical Data Management Practice (GCDMP), minimum standards in the design and development of DCF include: collecting only the data specified by the protocol; documenting the process for CRF design, development, approval, and version control; and keeping records of training of personnel on the protocol and DCF completion instructions.[9] The more effort you

put into designing DCF, the more chance you will be able to answer your research questions effectively and precisely. Collecting data is one thing, but more challenges still need to be taken into consideration for data quality checks prior to data analysis: data entry, data storage, data validation, and data transformation. These data management processes will be discussed in future articles.

Suggested Citation

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