SIGNS AND SYMPTOMS OF ACUTE RESPIRATORY INFECTIONS ASSOCIATION WITH AIR POLLUTION AMONG UNDER-FIVE YEARS CHILDREN IN THE MARGINALIZED COMMUNITY OF MAE SAI DISTRICT, CHIANG RAI PROVINCE

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MASTER OF PUBLIC HEALTH
IN
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SCHOOL OF HEALTH SCIENCE
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ABSTRACT

Introduction: In Thailand, the prevalence of fine dust, specifically particles measuring less than 2.5 microns, poses a significant environmental challenge. Annually, Thailand surpasses the standard air pollution threshold, particularly evident in the Mae Sai district where levels of PM2.5 exceed established criteria. This heightened pollution raises concerns for potential health risks, particularly respiratory diseases. Statistical data indicates a correlation between PM2.5 exposure and respiratory infections, with children being the most vulnerable demographic. Groups with limited access to healthcare services or residing in high-risk environments, such as marginalized populations, may experience a higher incidence of respiratory infections among children. However, further research is needed to conclusively determine the exact factors contributing to these infections.

Methods: A community-based cross-sectional study was conducted at Mae Sai district, Chiang Rai Province, Data collection in 2 periods into August-December 2022: before the smog period and January-May 2023 the smog period. by structured questionnaire. 284 participants were randomly selected into the study.

Results: A total of 171 participants who completed the questionnaire were eligible for the analysis in this study. The average age of the children was 2.50±1.47 years, and their mothers or caregivers had a mean age of 34.40±11.1 years. It was found that most of the mothers or caregivers had an education level of 'able to read and write' (31.0%). The majority of the family sizes tended to be large, with 78.9% having more than four members. Hand hygiene, face mask use, and vaccination are crucial in preventing infectious diseases and promoting children's long-term health. In this study, 67.8% of the observed children were fully vaccinated. Most of the children always washed their hands after outdoor activities (77.8%); however, 98.8% did not wear a mask when they went outside. The structure of the house and sanitary facilities are important factors that can contribute to the infection cycle for the children. Most houses in this study had in-house toilets with adequate sewage disposal (74.9%).

Moreover, poor ventilation in the kitchen during cooking activities can exacerbate the problem by trapping smoke and pollutants indoors. It was found that the houses in this study had windows in the kitchen (87.1%), which are essential for ventilating the air while cooking. The sources of energy for cooking were biomass fuels (46.2%), clean fuels (45.0%), and kerosene (8.8%). During the cooking activity, 44.4% of the children were not in the cooking area when their mothers or caregivers prepared the food, with an average time of 28.1±16.2 minutes per session. In addition, smoking and using aerosol spray products are among the causes of indoor air pollution for children. The findings of this study revealed that 40.4% of the families had cigarette smokers. However, when using spray cleaners or deodorants, 60.8% of the families kept the children away for an average time of 21.2±2.97 minutes. Outdoor air pollution was also observed in the study. The results revealed that 95.9% of the families burned trash inside the house area, and 90.1% of the children were indoors during this activity.

Furthermore, PM2.5 from agricultural burning is one of the causes of air pollution in Chiang Rai, particularly from January to May (smog period). The data

analysis in this study indicated a statistically significant association between signs and symptoms of acute respiratory infection and PM2.5 among children under five ($p < 0.05$). During the smog period, all of the five common signs and symptoms of acute respiratory infection among children, including cough (with or without fever) (OR = 3.91, 95% CI = 2.50-6.14, $p < 0.001$), rapid breathing or shortness of breath (OR = 14.4, 95% CI = 7.64-27.50, $p < 0.001$), difficulty breathing (OR = 10.2, 95% CI = 5.82-18.01, $p < 0.001$), wheezing (OR = 13.4, 95% CI = 6.42-28.00, $p < 0.001$), and sore throat (OR = 3.28, 95% CI = 2.01-5.38, $p < 0.001$) were higher compared to the non-smog period.

Conclusion: Research has demonstrated that during periods of air pollution or when PM2.5 levels exceed standard values, children are at a higher risk of developing signs and symptoms of acute respiratory infections compared to usual conditions. Children under the age of 5 are particularly susceptible and require close monitoring. Caregivers, including mothers, should focus on mitigating both short- and long-term exposure to pollution through careful selection of cooking materials, reducing indoor pollution, and ensuring proper nutrition, vaccination, and healthcare. These measures are essential for protecting children's immune systems, reducing risks, and lowering healthcare costs. Currently, both public and private entities are engaged in campaigns and initiatives, as evidenced by the Ministry of Public Health's efforts in managing smog (Ministry of Public Health, 2019).

Despite these endeavors, it is acknowledged that these issues persist. Prevention of respiratory infections in children necessitates protection both indoors and outdoors. This entails fostering an understanding of the issues, raising awareness about prevention methods, and acknowledging the potential impacts on individuals. Collaboration between the government and private sectors is imperative. Establishing clear guidelines, regulations, and stringent rules, such as those outlined in the Clean Air Act, is essential to mitigating these challenges and promoting sustainable health across all age groups.

Keywords: Acute Respiratory Infection in Children, Air Pollution, Marginalize

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CHAPTER 1

INTRODUCTION

1.1 Background, Significance, and Rationale

Acute respiratory infections (ARIs) are classified as upper respiratory tract infections (URIs) or lower respiratory tract infections (LRIs). The upper respiratory tract consists of the airways from the nostrils to the vocal cords in the larynx, including the paranasal sinuses and the middle ear. The lower respiratory tract covers the continuation of the airways from the trachea and bronchi to the bronchioles and the alveoli. An upper respiratory infection (AURI), including flu, pharyngitis, and tracheid·s epiglottitis and inflamed middle ear, and lower respiratory tract (ALRI) infections include bronchitis and pneumonia. Currently, it is the leading cause of death for young children in low-income or developing countries, the World Health Organization (WHO) estimates that one-third of all deaths in children under the age of 5 (4.3 million de facto deaths in 1996) are caused by ARI, symptoms of acute respiratory infection are coughing, with or without fever, and sore throat, frequent breathing, difficulty breathing, or wheezing (Simoes et al., 2006). The cause of acute respiratory infection is caused by virus, bacteria, and environmental factors such as air pollution that cause acute symptoms (Simoes et al., 2006). Acute respiratory infections are more common in children than adults becausechildren are in the process of developing and building immunity, therefore life is at greater risk of exposure to environmental factors than adults. Especially in, marginalized or underprivileged and children are found to be at high risk of exposure to air pollution due to lack of access to health services and economic conditions (World Health Organization [WHO], 2018a).

Air pollution is a problem that affects the health and economy of a country, and the health effects of air pollution can be divided into two stages. It's short-term and long-term. Short-term effects result in eye irritation, acute asthma, cough, wheezing, and frequent breathing. Long-term effects there are a risk of lung cancer, chronic

obstructive airway disease, and cardiovascular disease. Because of its health impact, the World Health Organization has developed guidelines to control air pollution. From this health impact and the United Nations (UN) has set a sustainable development goal of 3: Ensure healthy lives and promote well-being for all at all ages. Target 3.9: By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination. Indicators 3.9.1: Mortality rate attributed to ambient air pollution (2022 Global SDG Indicator Platform, 2022). In Thailand, guidelines and health improvement plans have been established, and the Ministry of Health has prepared an operation manual for PM 2.5 cases, but it is still found that in Thailand, fine problems of dust with less than 2.5 microns are major problems in Thailand. This is because the level of air pollution in Thailand exceeds the standard every year. It is recommended by the World Health Organization (WHO) that the annual average of PM 2.5 should not exceed 10 $\mu g/m^3$. and the 24-hour average of PM 2.5 should not exceed 25 $\mu g/m^3$. Thailand's PM 2.5 value was found to have an annual average of 25 $\mu g/m^3$, and the 24-hour average of PM 2.5 was 50 $\mu g/m^3$. This exceeds the standards recommended by the WHO (Greenpeace Thailand, n.d.). As a result, air pollution problems continue to be observed every year, which is very common in the north, central regions. The health effects of PM 2.5 exposure are also increasing every year during the dry season (March-July), according to the smog report (Air Quality and Noise Management Bureau Pollution Control Department, 2019a, 2019b, 2020a, 2020b, 2021a, 2021b) In the area of Wiangpangkam, Chiang Rai Province, it was found that during March and April, it was the period when PM 2.5 was the most high. In 2019, it was found that March had a high PM 2.5 of 357 $\mu g/m^3$. April had a PM2.5 of 220 $\mu g/m^3$. In 2020, March has a PM2.5 value of 398 $\mu g/m^3$, and April has a PM2.5 value of 206 $\mu g/m^3$. In 2021, March had a PM2.5 value of 414 $\mu g/m^3$, and in April, a PM2.5 value of 357 $\mu g/m^3$. From the report, a PM value of 2.5 was found to be greater than 90 $\mu g/m^3$., indicating that air had a health effect.

Air pollution is a silent killer that causes premature loss of life. According to reports, 3.8 million people worldwide die prematurely every year from air pollution and most deaths are found in South and Southeast Asia, more than 2 million. The most affected were women and children under the age of five, with the cause of death being pneumonia showing 21 percent. In addition, according to a U.N. report, Mortality rate

attributed to ambient air pollution showed that Thailand accounted for 30.36 percent of air pollution respiratory infections, divided by 29.32 percent male and 31.44 percent female (World Health Organization [WHO], 2024, n.d.). And there are 100,000 deaths per child, classified by region and income level. The WHO found that 80.5% in children under the age of five and 75% in Southeast Asia in children under the age of five (World Health Organization South-East Asia, 2020). In Thailand, according to a study, children aged 0 to 14 who are in areas with PM 2.5 above the standard, as vulnerable groups, suffered a significant health impact of 44.1%, and 73% were found to be admitted to the inpatient service with lower respiratory infections (Teeratakulpisarn et al., 2012). The Department of Health found that a PM 2.5 value of 50 μg/m^3would affect children's health, affecting the respiratory system by 5.7%, and a PM 2.5 value of 37 μg/m^3or less would affect children's respiratory system (The Royal College of Pediatricians of Thailand & Pediatrics Society of Thailand, 2019). According to the report, the health department (Health Data Center, 2019a, 2019b, 2020a, 2020b, 2021a, 2021b). The Office of the Ministry of Health of Chiang Rai, back three years, found that in 2019, Chiang Rai had a rate of respiratory disease among children under the age of five, 41 percent to 73218 people per 100,000population. In 2020, 40 percent to 63145 people per 100,000 populations, and in 1964, 39 percent to 56654 people per 100,000 populations. In the area of Wiangpangkam, Mae Sai District, where air pollution exceeding the standard has affected health, showed a respiratory disease rate among children under the age of 5 in 2019, 0.7 percent to 45026 per 100,000 populations, in year 2020, 0.8 percent, to the population 29166 per 100,000 populations, and in 2021 of 0.7 percent, to the population 27496 per 100,000 populations.

In Thailand, there are many dust monitoring points, and every year, in the northern region, several provinces are found to have dust levels exceeding the standard. One of them is the dust monitoring point in Wiang Pang Kham Sub-district, Mae Sai District, Chiang Rai Province. As a result of the report, in Wiang Phang Kham Subdistrict, Mae Sai district area, there is a problem with PM 2.5 higher than the standard criteria every year. There may be a risk of disease, and with statistics of respiratory infection with similar statistical values, it may be consistent with factors including PM 2.5. By PM 2.5, there is the greatest risk to children because childhood is a more life-spanning age than adults, and there is a relatively high risk of exposure,

and children spend more time playing outdoors than indoors. Especially in ethnographic areas, with culture, lifestyle can put children at a high risk of developing acute respiratory infections, and in young children, with fuel lifestyles as cooking grounds, mothers are always putting children stay beside them, making them more likely to exposure dust than adults. In addition, childhood is the age of the body and immune system changes, so it is a risk age when exposed to antigen (World Health Organization South-East Asia, 2020). Therefore, if properly corrected or properly and quickly treated, it will reduce long-term costs, further reducing the risk of developing severe disease. There are currently campaigns to prevent, and control environmental factors affecting health. Statistics show only those who come in for services in hospitals, but for a marginalized group with limited access to services or in a risk environment, there may be a large group of children with respiratory infections. This is uncertain and there are no further studies on the exact associated factors. Therefore, this aims to study the prevalence of acute respiratory infections and symptoms among children under five years and the relationship between exposure to air pollution and acute respiratory infection among children under five years of age in Mae Sai District, Chiang Rai Province. The results of this study will to implement a system for care, prevention, and monitoring in signs and symptoms of acute respiratory infections in children for you at public health, parents. Develop a policy to reducing indoor air pollution exposure and limit the incidence of acute respiratory infections, especially among marginalized communities, and the findings can be applied to future research to expand the combined treatment approach to address acute respiratory infections among marginalized community.

1.2 Objective

To investigate association between air pollution and sing and symptoms of acute respiratory infections among children under five years of age in the marginalized community, Mae Sai District, Chiang Rai Province.

1.3 Research Question

Is air pollution associated with signs and symptoms of acute respiratory infections in children under the age of five in marginalized communities, Mae Sai District, Chiang Rai Province?

1.4 Operational Definition

1.4.1 Signs and symptoms of acute respiratory infection in children are defined as a child who has a Cough, with or without fever, and sore throat, difficulty breathing, wheezing in the 2 months prior to the survey (Simoes et al., 2006).

1.4.2 Air pollution refers to outdoor air pollution and household air pollution. That causes PM 2.5. PM 2.5 values exceed the health-effect standard. PM 2.5 should not exceed 25 micrograms per cubic meter (World Health Organization).

1.4.3 PM 2.5 is During the month when PM 2.5 value exceeds the standard, it is January-May.

1.4.4 Without PM 2.5 is During the month when PM 2.5 value under the standard, it is August-December.

1.4.5 The source of energy used for cooking will be classified into three categories: (1) biomass fuels (wood, dung cakes, charcoal, urban residues, firewood); (2) kerosene, and (3) clean fuel (liquefied petroleum gas, electricity). Unclean fuel types consisted of biomass fuels and kerosene. For households in rural villages, an improved stove will be a cooking stove made from mud, animal dung, or cement with a vent to channel fumes outdoors.

1.4.6 Marginalized Group-refers to those who are at the edge of society due to lack of access to rights, resources, and opportunities as the main cause of vulnerability. Which means exposure to various dangers that could happen and cannot adequately deal with these dangers. The marginalized communities are defined as ethnic communities, migrants, asylum seekers, migrant workers. Limited access to medical care and those who have no rights or are treated unfairly (International Federation of Red Cross and Red Crescent Societies, n.d.) in Mae Sai District, Chiang Rai Province

1.4.7 Sanitation facility (1) In house toilet with adequate sewage disposal (2) In house toilet with not adequate sewage disposal (3) Public/ community toilet with adequate sewage disposal (4) Public/ community toilet with not adequate sewage disposal.

1.5 Conceptual Framework

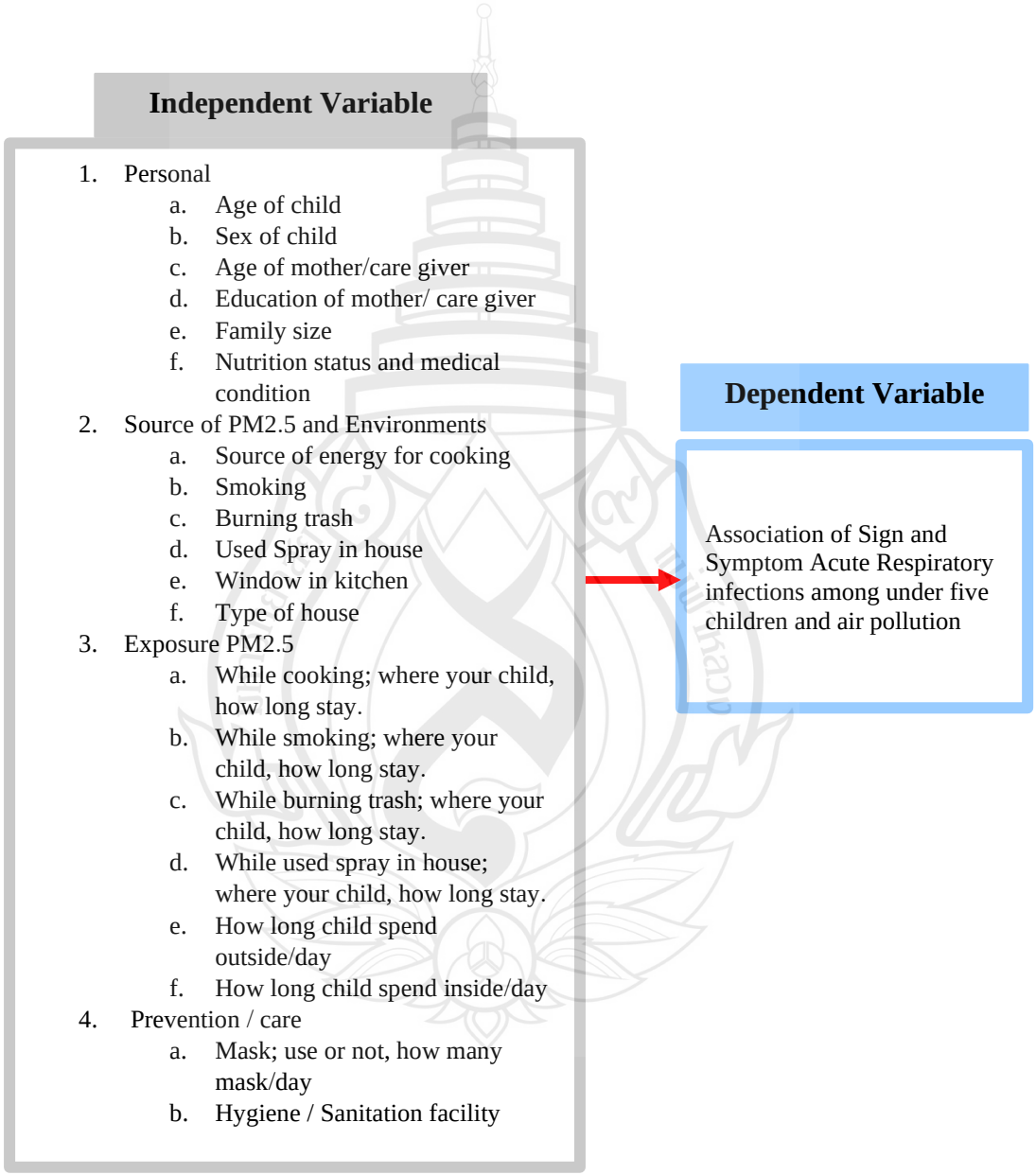


Figure 1.1 Conceptual Framework

CHAPTER 2

LITERATURE REVIEW

The present study, investigating the prevalence of signs and symptoms of acute respiratory infections and their associations with air pollution in children under five years of age, was conducted in the marginalized community of Mae Sai District, Chiang Rai, Thailand. Therefore, the literature review focused on the following aspects:

2.1 Acute Respiratory Infection in Children

2.2 Signs and symptoms of acute respiratory infection in children

2.3 Air pollution (PM 2.5)

2.4 Sources of PM 2.5

2.5 Marginalized health

2.6 General Information of the Study Area

2.7 Other related research

2.1 Acute Respiratory Infection in Children

Acute respiratory infections in children are common in both developing and developing countries and are the cause of the morbidity and mortality rate in children under the age of 5. In some cases, if they survive, there may be respiratory abnormalities, and other systems such as sinusitis, chronic bronchitis, bronchiectasis, etc. 70% of children under the age of 3 suffer from respiratory diseases. In Thailand, pneumonia mortality topped infectious diseases among 52% of children under the age of 5 and 25% of children under the age of 1 were found to die of lower respiratory infectious diseases (Keleb et al., 2020; The Royal College of Pediatricians of Thailand & Pediatrics Society of Thailand, n.d.) Acute respiratory infections are classified into two categories: acute upper respiratory infections and lower respiratory infections. The upper respiratory tract starts from the nostrils to larynx, including maxillary sinus and middle ear. The

lower respiratory tract starts from trachea and bronchioles to the alveoli (Simoes et al., 2006). Upper respiratory infections are the most common infections, including flu, acute otitis media, acute rhinosinusitis, acute pharyngitis, acute tonsillitis, and lower respiratory infections include acute bronchitis, acute bronchiolitis, acute pneumonia, and Crohn's syndrome including acute laryngotracheobronchitis (viral croup), acute epiglottitis, bacterial tracheitis, retropharyngeal abscess (Association of Respiratory Syndrome and Critical Pediatrics in Children The Royal College of Pediatricians of Thailand, 2019). In diagnosing, clinicians diagnose in the disease code group J00-J99 Disease respiratory system, J00-J06 acute upper respiratory infections; J06 Acute upper respiratory infection of multiple and unspecific sites; J06.9 Acute upper respiratory infection, unspecified.

Acute respiratory infections are caused by exposure to antigen into the body, most found by viral or bacterial infections. When the body receives antigen, it causes the body to react to the antigen, and the body builds up immunity by the function of white blood cells. The body's response will show more acute symptoms such as coughing, sneezing, sore throat, and if the body accumulates antigen in the long term, it affects the immune system in the body. It also affects the function of other systems. Therefore, signs and symptoms of acute respiratory infection are found to have symptoms, cough with fever or no fever, sore throat, cold, shortness of breath, wheezing, or difficulty breathing (Simoes et al., 2006).

In addition to the factors of infection that enter the body during the period of low immunity, there are other factors that contribute to signs and symptoms of acute respiratory infections, such as environmental factors such as air pollution derived from industrial dust, vehicle fuel combustion, forest burning, waste air generation, smoke-causing cooking, household fuels, etc. Cooking gas, charcoal, wood, house cleanliness, cigarette smoke, etc. as well as season by rainy season are a risk to pathogens, summertime. Where air pollution occurs, or even hygiene contributes to the common cause of infection (Simoes et al., 2006).

Among them, when acute respiratory infections occur, there are various treatments by dividing the treatment into three categories: (1) General care focuses on behavioral adjustment, diet, sleep, and drinking water to strengthen the body's self-recovery and build immunity on its own, avoiding being in crowded places, reducing

spread of infection and infection. (2) is symptomatic treatment. If you have a fever above 38, take a fever reducer from time to time every 4-6 hours. If you have a sticky nose or a sore nose, it is difficult to breathe, and drop it. 0.9% NSS on one or two drops each or use a cotton swab to soak warm water or salt water into the nostrils to clear your breath, use a group of decongestant drugs to reduce the swelling of Nasal mucosa and nasal discharge. In Thai science (Thongporn, 2020), beat the fine red onion, mix hot water, and inhale it to relieve nasal secretion, or wrap it in a hot-water-plated cloth, and place it near the baby's head so that the oil evaporates to relieve nasal secretion. Relieve cough. By using medicine, soothing remedies group reduces cough together with dry throat, choking drinks with warm water mixed with lemon honey, cough suppressants such as codiene, dextromethorphan, but will cause sputum and may require a sputum solution. The final type, specific treatment, is used in the event of symptoms expressed in specific organs or severe symptoms such as antibiotic use. Conditional use for 5-7 days to sterilize, endotracheal tube insertion. In the case of acute epiglottitis, Penicillin or ampicillin injection treat severe pneumonia, in children under the age of 5, airway dilatation was selected for children who were found to have lower respiratory tract infection with Wheeling. moreover, advice is an important part by avoiding infectious factors such as reducing being crowded, taking care of hygiene, in areas where the environment is clear, modifying the behavior of both food and drink, and sleeping to strengthen good immunity.

And if it is prevented at the root cause, it reduces the risk of infection and reduces respiratory infections because the child is in a period of development both organically and physically. The WHO (Simoes et al., 2006) has identified four categories: (1) Specific antiseptic vaccinations, (2) Early treatment and diagnosis, (3) Nutrition Management and Healthcare. (4) Safe Environment. In the advice in 1 and 2, it is something within the scope of the public health system that must be involved in the care, and in the advice in 3 and 4, it is something that the public must have a common awareness of to supervise.

2.2 Sign and Symptoms of Acute Respiratory Infection in Children

Acute respiratory infections are caused by exposure to antigen into the body, most found by viral or bacterial infections. When the body receives antigen, it causes the body to react to the antigen, and the body builds up immunity by the function of white blood cells. The body's response will show more acute symptoms such as coughing, sneezing, sore throat, and if the body accumulates antigen in the long term, it affects the immune system in the body. It also affects the function of other systems. Therefore, signs and symptoms of acute respiratory infection are found to have symptoms, cough with fever or no fever, sore throat, cold, shortness of breath, wheezing, or difficulty breathing (Simoes et al., 2006).

Of the signs and symptoms of acute respiratory infection, cough caused by inflammation, from infection, it is common in colds, itching and sore throat, and can be classified into three types: Dry coughs, throat irritation coughs and sputum coughs, and it is found that in addition to viral infection, bacteria may be caused by choking foreign things into the airways, when some coughs do not require medication, they heal themselves or honey is used to relieve coughs, and relief honey is recommended for children 12 years of age or older (Kids Health Information, 2020). Sore throat is another symptom shown when infected and can occur with cold, pharyngitis, acute epiglottitis opening lid inflammation, lymph node swelling, and retropharyngeal space. These inflammations will make children feel sick, uncomfortable, and have a higher body temperature. The primary treatment is to drink enough water and rest. In Thai medicine, herbal medicine containing honey is used to help relieve sore throat (Office of the Permanent Secretary, 2018). Cold is an infection of the nasal cavity, and is found in children with Sneezing, watering eyes, mild fever and childcare. Mothers and caregivers must pay attention to keeping children in clean, air- conditioned areas, reducing exposure to crowded areas and spreading infections. Children's shortness of breath is faster than normal breathing of children over two months old with a rate of 60 times/minute. 2 months-12 months old with a rate of 50 times/minute and 1 to 5 years old with a rate of 40 times/ minute. Breathing sometimes does not require medical devices to assist because it can be heard, breath sounds occur bronchial vibration, and

when small airway obstruction occurs, causing pressure to cause wheezing, showing signs of asthma risk, 60% of children with wheezing in the first three years are found to disappear at the age of 6 (The Royal College of Pediatricians of Thailand & Pediatrics Society of Thailand, n.d.).

Acute respiratory infections are found at all ages but are found a lot in children under the age of 5 (The Royal College of Pediatricians of Thailand & Pediatrics Society of Thailand, n.d.). Because the child is a growing age, developing the body, it is an age that receives strange things with relatively simple and frequent responses. Acute respiratory infections are divided into two (Simoes et al., 2006) Symptoms will be cough with fever or no fever, shortness of breath, difficulty breathing, wheezing, the first cause of respiratory infection is a viral infection, bacteria, and moreover, a lot from the surrounding environment, weather conditions, various pollutants (Simoes et al., 2006). Most people neglect it in their initial symptoms, but if accumulated not to prevent the cause; it can affect the body in the long run, raising the risk of serious diseases in the future (Association of Respiratory Syndrome and Critical Pediatrics in Children The Royal College of Pediatricians of Thailand, 2019). Currently, only care is provided at the terminal, where both modern Drugs, Thai medicines are used, providing WHO with preventive guidelines to reduce the occurrence of acute respiratory infections that will lead to serious diseases and potentially death in the future (Simoes et al., 2006).

2.3 Air Pollution (PM 2.5)

Air pollution is the contamination of indoor or outdoor air from gases and solid particles that alter the natural characteristics of the air, with major health hazards including fine dust (PM 10, PM 2.5), carbon monoxide (CO), ozone (O3), black soot (Black carbon), sulfur dioxide (SO2), and nitrogen oxides (NOX). PM 2.5 micro-fine dust is a key measure used to assess the health effects of air pollution and is an air pollutant that governments around the world generally measure or monitor to protect people from adverse effects from air pollution. Air pollution is often invisible to the naked eye because these particles are too small for the human eye to see but may be

visible in certain situations, such as smog caused by burning agricultural waste or burning waste in open spaces, as well as smog from burning coal wood, fuel and diesel, for food and heat power generation, transportation, and transportation. And the generation of electricity, even if we can't see it with the naked eye, doesn't mean that there.

Small fine dust affects various health effects, depending on the level of exposure to the touch, and the duration of exposure to the touch. In the short term of 8 or 24 hours, eye irritation, cough, difficulty breathing, wheezing, frequent or rapid breathing, acute asthma, and acute lower respiratory tract infections reach the lungs. If the long term, regardless of the high or low level, increases the risk of respiratory infection, asthma exacerbation, airway inflammation, chronic effects, lung cancer, chronic obstructive airway disease, heart disease and cardiovascular disease, neurological effects, children's behavior, brain impairment ability, and autism. The effect on the reproductive system affects pregnant mothers. It results in premature birth, underweight birth of the first baby, and results in clotting and premature death (World Health Organization South-East Asia, 2020). The individuals affected will vary, especially in rural and suburban areas where wood is burned, agricultural waste for fuel, food composition, thermal power generation, and lighting power generation may result in prolonged and large amounts of air pollution, as well as in densely populated, congested urban areas.

Those vulnerable to exposure to air pollution include children, especially children under the age of 5 and the elderly, who are particularly vulnerable, and include those with identity diseases such as asthma, respiratory diseases, cardiovascular disease, pregnant women, or poor nutrition, construction workers, traffic police, and resident's roads, people who work outside buildings in highly polluted areas, people who smoke and who are exposed to cigarette smoke. Every year, 7 million people die from exposure to air pollution in general or households. It is most common in South and Southeast Asia, more than 2 million people are affected by children under the age of 5, followed by pneumonia, followed by women cooking in smoke-filled households and finally groups of people working outdoors, such as construction groups, traffic police. The sources of air pollution are classified into two categories: (1) Outside of buildings or general atmosphere, called Ambient air pollution. Outdoor air pollution

sources such as industrial facilities, power generation facilities, coal power generation facilities, transportation, waste and waste management facilities, farmland or agriculture, forest combustion or leaf debris. (2) Indoor or domestic, referred to as Household air pollution, domestic air pollution sources such as cooking, domestic energy consumption such as charcoal, wood or gas fuel, energy consumption such as building fires to relieve cold weather in rural areas, smoking cigarettes, indoor congestion. 3.8 million people around the world die prematurely every year from domestic air pollution caused by cooking (World Health Organization [WHO], 2020) such as wood used by polluting furnaces, burning in open spaces, lamps, and women and children are the most vulnerable. 21% of air pollution-related diseases, including pneumonia, stroke, 20% of myocardial infarction, are found.34 chronic obstructive pulmonary disease found 19 percent and lung cancer found 7 percent (World Health Organization South-East Asia, 2020).

For children, when exposed to air pollution, it results faster than adults, and receives more health effects than adults, and children are in a period of steady growth, and children have faster breathing, more food intake than adults, and their body systems continue to develop in the nervous system, immunity, reproduction and central digestive system of the body. As a result, if exposed to air pollution in the stage of development, it poses a risk of development that is delayed or so severe that it is irreversible, and with children's different behavior, with the way children live, they will face more exposure to air pollution than adults. Children spend most of their time outdoors or indoors in the kitchen, making these factors contribute to relatively large amounts of air pollution. For example, young children crawling in the ground may expose them to dust and chemicals accumulated on the soil, where they are not as capable of controlling and deciding health risks as adults. Environmental risks account for: Twenty-five percent of diseases occur in children under the age of five. Children's health problems are often caused by exposure to many environmental factors in the place of residence, work, play, and learning (World Health Organization, 2024, n.d.). Among infants or fetuses, mothers spend most of their time indoors, which is more vulnerable to exposure to indoor air pollution. For example, mothers raising children will keep their children close even while cooking in the kitchen, making them vulnerable to air pollution from cooking, etc. The WHO identified the effects of

exposure to air pollution in children as contributing to neurological development, resulting in decreased cognitive function, mental and motor effects, damaging lung function, which found that children under the age of 15 were exposed to PM 2.5 at levels exceeding 93 percent of the criteria set by the WHO, including children under the age of 5 who were exposed to PM. 2.5 630 million people and 1.8 billion children under the age of 15 were found in as many as 98 percent of low and middle-income country areas (World Health Organization, 2018b).

In Thailand, 73 percent of children under the age of 5 come to the OPD for acute respiratory infectious disease. Pneumonia is the number one cause of hospitalization, accounting for 3.22 percent of the disease rate and 11.29 percent of the child's population (Teeratakulpisarn et al., 2012). In addition, in Chiang Rai, one of the provinces affected by air pollution, health results were reported from the health data center [0, 0, 0]. The Office of the Ministry of Health in Chiang Rai found that 43% of children under the age of 5 in 1964 were sick, and 17% of children under the age of 5 were found in Wiangpangkam, Mae Sai District, where air pollution problems exceeded the standard, resulting in health problems.

Therefore, air pollution consists of contamination of various toxic substances when exposed in a short or long period of time, especially in children under 5 years of age, pregnant women, outdoor working groups, and in developing and underdeveloped countries. Air pollution sources are generated both outdoors and indoors. Therefore, the child's behavior of spending time playing, learning, and the period of body development makes them risk to exposure to air pollution, which results in long-term respiratory diseases such as pneumonia, asthma, chronic bronchitis, etc. The WHO has set the PM 10 fine dust value at 50 $\mu g/m^3$and PM 2.5 value at 25 $\mu g/m^3$If a person who has been exposed to air pollution exceeding the standard set by the Health Organization for a short and long period of time, it will affect his or her health and may be serious enough to cause death. These problems have led the WHO to recognize and establish prevention plans, including establishing guidelines for healthy living, stating goal 3: Ensure healthy lives and promote well-being for all at all ages. Target 3.9: By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination. Indicators 3.9.1: Mortality rate attributed to ambient air pollution (2022 Global SDG Indicator Platform, 2022).

2.4 Source of PM 2.5

The source of 2.5 microns of fine dust is from two sources: from the outside of the building and from the inside. The cause of PM 2.5 has been investigated mainly by combustion, both from engines and burning materials such as burning waste in the open, burning leaf fragments, wood chips for fuel, etc. According to the Ministry of Energy's 2006 Energy Report, 54 percent were found to be caused by combustion, 17 percent by industrial facilities, 13 percent by transportation, 8 percent by power generation plants that emit air toxic fumes or wastes, and 7 percent by residences. In China, according to a study on Household fuels excluded power plants, car as smog source in Beijing, toxic fumes are caused by burning fuel for cooking or heating in the home rather than by cars and power plants in winter (Liu et al., 2016). Therefore, sources of PM 2.5 occur from outside of buildings such as open- air combustion, industrial facilities, power generation, transportation, and other gas concentrations, and from inside of the building, which is an active site, are places where we spend more time than outside, PM 2.5 can also occur. PM 2.5 comes from indoor combustion of fuel, appliances, crowded air, etc. where housing is important for health due to changes in the entire population, expansion of land, and climate. The world's population over 60 years of age will double in 2050. This allows the population to spend more time in their homes, with dwellings playing an important role in both direct and indirect health. For example, structures without strength will harm the body, areas exposed to air pollution, accumulation of toxic substances, long- term health risks, residential conditions within the home. A relatively high temperature in house affects the respiratory and cardiovascular systems, in addition, indoor air pollution affects a wide range of non-contact diseases, triggers irritation, triggers allergic reactions of the body such as asthma, crowded addresses increase the risk of infection, inadequate water facilities and sanitation, affecting safety, and can increase serious health risks in the long term.

WHO has discovered that indoor and indoor air has more severe toxic contamination than outdoor air. Toxins or pollutants found inside the house or building include: (1) Biological pollution, (2) Chemical pollution and (3) Toxic materials (Healthy Housing Reference Manual).

1. Biological pollution, including bacteria, mold, viruses, pet skin, cat saliva, dust mites, cockroaches, and pollen. It has health effects such as measles, influenza, etc. Cockroaches, both body parts and spleen, trigger asthma, allergens in the spleen or feces of cockroaches can cause allergies, research by Crain et al. (2002) out of 994 children from seven U.S. cities found that 58% of homes found asthma among people with allergic reactions, so cleaning was important, to reduce the balance of stimulants in body. dustworms, another group of asthma effects, are found to contain a lot of allergens, with dustworms growing well in relative humidity of 70-80% being found a lot in bedrooms, beds, stacked along various carpets, so vacuuming is advisable to reduce the accumulation of dustworms. Pets are inevitable for some home populations, especially children, to be at greater risk of exposure than adults. The United States has reported that pets may be a major catalyst for asthma as dead skin, urine, feces, saliva of animals lead to asthma stimulation, reduced exposure or clean up areas where animals live, and combined time spent during bedtime is a measure of the risk of developing asthma. Pets are inevitable for some home populations, especially children, to be at greater risk of exposure than adults. The United States has reported that pets may be a major catalyst for asthma as dead skin, urine, feces, the saliva of animals lead to asthma stimulation, reduced exposure or clean-up areas where animals live, and time of Sleeping spent together with animals reduce the risk of developing asthma to a certain degree. Mold, including yeast and mushrooms, grows well in indoor environments, appears in cotton, yellow, white, black, sugar or green colors, found in wood, cellulose, in cardboard, wallpaper, carpeted glue or found in dust and dirt, which in a review of medical institution scientific literature (IOM) found correlation of mold exposure and other substances. Moisture, resulting in upper respiratory syndrome, inflamed lungs are sensitive, as well as causing direct lung damage. Mold grows in humid areas, moisture sources found indoors, such as roofing, wall joints, drains, and water with a balance in various electrical appliances such as dishwashers, refrigerators, etc. WHO has made recommendations for minimizing mold exposure and sources by adjusting indoor air systems to be clear, checking water pipes, maintaining proper relative humidity, providing dehumidifying equipment, avoiding mold- forming materials, etc.

2. Chemical pollutants include carbon monoxide, ozone, cigarette smoke or preferably secondhand cigarettes, organic compounds, radon, agricultural hazardous materials. Carbon monoxide is a pollutant caused by combustion, and it can be found in heating, cooking, cooking equipment such as gas-fueled oven, charcoal grill, wood stove, gas-fueled heater, etc., and children under the age of 5 and the elderly were found to be the group with the largest death rate caused by carbon monoxide exposure. CO is an odorless, colorless gas. When exposed, it may experience headaches, dizziness, fatigue, nausea and vomiting, chest pain, and confusion, the American Lung Association found that exposure to low levels of CO causes fatigue and increases chest pain in chronic heart disease patients and, if exposed to higher levels, causes flu-like symptoms, and when received CO, at very high doses, is at risk of death. Ozone exposure can damage the lungs, inhaling ozone in small amounts results in chest pain, cough, shortness of breath, and throat irritation, and ozone also affects severe chronic respiratory diseases such as asthma, and the Food and Drug Administration has set an ozone limit of 0.05 ppm. Cigarette smoke, or secondhand smoke, the National Cancer Institute says the environment where cigarette smoke is a combination of two forms of smoke: (1) Side smoke or puffy smoke, (2) The main source of smoke, or smoke inhaled by smokers, causes asthma, irritation to the eyes, nose, and throat, which can cause ticks. Children's ear infections, respiratory diseases, lung cancer, and the National Cancer Institute have been analyzed in the laboratory. Cigarette smoke contains more than 4,000 substances, 60 of which cause cancer, and has also been found to have negative learning and behavioral effects in children. Organic compounds vaporized into vapor VOCs. These substances are contained in household products such as cleaning products, accumulated fat cleaning products, sterilization, cosmetics, etc. They are also contained in spray-type products such as dry-cleaning products, vanishes, glue, art supplies, cleaners, floor waxes, scrubbers, and conditioners. Therefore, make the level of indoor VOCs higher than outside. This chemical exposure affects childhood leukaemia, affects pregnant women because it affects the fetal nervous system, affects children's development. EPA has identified methylene chloride as a common component of the stripper, spray paint when exposed to the body, and changes to CO in the body. It raises the risk of cancer. Another substance, formaldehyde, is colorless, easy to catch fire at room temperature, has used many industries such as adhesives that

produce compressed wood, rubber manufacturing, photographic films, leather, dyes, surface pigments, etc. The source materials include compressed wood, foam using heat insulation, curtains and carpeting if exposed to a high degree of color. More than 0.1 ppm may cause watery eyes to feel hot on the eyes, nose, and Neck, nausea, coughing, chest tightness, whistling breathing, skin rash, and allergic reactions. Therefore, the U.S. Consumer Safety Commission office CPSC has recommended reducing formaldehyde levels: ventilation, opening doors and windows, installing exhaust fans, if possible, to avoid using products containing these substances. Radon is a colorless, odorless, and sensory-impaired radioactive gas. Radon is the second leading cause of human lung cancer, followed by cigarettes. Radon is a decomposition of radium minerals mixed in common soil and rocks, so the amount of radon depends on the amount of radium and uranium. When a building is constructed, using stone, soil or sand, radon is emitted; if the building does not have a ventilation system, it is a source of radon that causes health effects, and radon sources include uranium in soil, groundwater, building materials, and natural gas. In Thailand, research on indoor and outdoor radon risk in community areas has been conducted, and indoor gas levels are found to be in the range of 9-1307 Bq/m3 above the US EPA standard setting of 148 Bq/m3 based on the number of lung cancer patients in the area, and higher than those of other causes (National Cancer Institute, n.d.). Agricultural hazardous materials such as pesticides, pesticides, and pesticides affect the occurrence of hazardous chemicals in the air and accumulated inside the surface, or materials in the house, as an increase in health risks, so safe use of the product should be considered.

3. Toxic materials include Asbestos, Lade, Arsenic, where Asbestos is a natural mineral mixed in rock, fine fiber type, special properties that are fire resistant, non-heat-conductive and electrical, rigid, and flexible, are spun into a line and woven into a fabric, well-tolerated and stained, and are used as a mixture of many products such as roof tile-type, ceiling, and vinyl. Flooring, brake pads, heat insulation and textile industries, etc. The health effects when Asbestos enters the body will cause pneumonia because Asbestos will cause lung collapse, easy fatigue, chronic cough, weight loss, fatigue, difficulty breathing, and chest pain, lung cancer and membrane cancer, etc. Lead is found in equipment such as fishing gear, cable covers, batteries, etc. It is also found in contaminated soil, food from lead-containing containers, drinking

water from water system corrosion, etc. Lead dispersing anywhere causes health effects, either short-term allergic reactions or long-term accumulation. That causes chronic diseases. Arsenic is a heavy metal compound accumulated in the soil, found in the surroundings of houses, wells, tree orchards, some agricultural areas, and health effects on arsenic exposure result in acute symptoms and chronic diseases such as abdominal pain, nausea, diarrhea, skin cancer, neurotoxicity, diabetes, lung disease, and cardiovascular disease. Learning, etc., arsenic can enter the body both by touch, by eating, because in food and water, arsenic is a very common source (World Health Organization, 2018c).

Each year, about 3.8 million people die prematurely from illnesses caused by household air pollution, caused by inefficient use of solid fuel and kerosene in cooking, housing is related to health effects, and infections are also caused. In rural communities, marginalized communities are at high risk with their financial status, resulting in the relatively low choice of home cooking materials, and cooking is one of the things that marginalized communities prefer to cook by burning fuel, which can result in respiratory infections as well as generating heat. In winter or rain there will be fuel burn. Therefore, addressing is another important factor. We will spend more than 70% of our time indoors or indoors. The risk of air pollution will be high, affecting both short and long-term, especially in children under the age of 5, rural women, elderly people, and remote or rural areas. According to the way of living, fuel for cooking, construction, or the area around residential areas, water sources, water consumption and hygiene are still used, as parts that cause accumulation of air pollution. Prevention and awareness of safety, cleanliness and air clearance are therefore important to create these things for the population to become more awareness.

Air pollution is air pollution of various particle sizes, but it is not visible to the naked eye. PM 2.5 is a relatively large pollution that affects health. In the short term, it causes eye irritation, cough, difficulty breathing, asthma, and if exposed in the long term, serious chronic diseases such as bronchitis, lung cancer, heart disease, etc. Children who spend most of their time outdoors are at risk of long exposure, resulting in slower development of children, which can cause premature death (World Health Organization South-East Asia, 2020). PM 2.5 is sourced from both indoor and outdoor. From the indoor, it can be found that the use of fuel for composition, the choice of

products containing evaporated organic compounds as VOCs, the use of indoor materials containing toxic materials, and cigarette smoke all cause PM2.5. In addition, most of the causes of PM 2.5 are burning outside, industrial facility waste discharges, and transportation all form large PM2.5s and are accumulated across various sources of houses (World Health Organization, 2018c). So when exposed to short-term or long-term exposure all affects the body.

2.5 Marginalize Health

Good health is another important goal of life, and the World Health Organization's 1938 health means good physical, mental, and spiritual health without disease and disability, and can live a happy daily life in accordance with the goals of the Ministry of Health. The three elements that are linked are (Sukmag, 2018): (1) Individual elements are people's behavior such as inappropriate consumption, work behavior neglecting safety, etc., genetics that people find most. Genetically transmitted diseases such as diabetes, high blood pressure, etc. Ideas, beliefs about health are influenced by parenting or by learning, various technological media. (2) The surrounding state composition consists of: With economic growth, hospitals, new services have been built to accommodate, raising expectations for people to receive convenient and quality health services. Educationally, as a result, self-care literacy and people around them, administrative politics is a large-scale organization that contributes to the cooperation of people in health care through various policies through entrepreneurs, creating a wide range of collaboration between the public and private sectors. In terms of infrastructure, the development of media technology enables people to understand, access service information, disease information, prevention information, more quickly, accurately, as a source of knowledge for people interested in health. Technology is technologically advanced, and it has both positive and negative effects. Medical technology has evolved to provide fast, timely services, but it must be exchanged for higher capital costs, resulting in some people's inability to use the services. Other areas, such as culture, faith, values, morality, and ethics, affect both good and bad aspects such as smoking, alcoholism, drugs that often occur in young people who want to experiment with

changing demographics, lower birth rates, higher average life expectancy, and the migration of workers from a wide range of legal and illegal places. The health of mangrove, in terms of changing surroundings such as the number of forests, has decreased, affecting the ecosystem, including climate, soil conditions, and environmental conditions. It affects livelihoods, contributes to habitat, biological, microbial changes. It comes from insects and animals that lead diseases, affects health, healing, and some microorganisms evolve according to ecosystems, causing drug resistance. (3) Components of public health systems include: The diversification of public and private health service infrastructure such as hospitals, health stations, the creation of more comprehensive health insurance, and the creation of services accessible to all areas, contributes to the well-being of the people. Structured Health Administration Integrated Healthcare System (Integrate) centralized people by age, managed healthcare by age, and holistic healthcare, quality, and efficiency in services. Now more service freedom has emerged, increasing business competition, financial, price, and increasing service competition. Nursing facilities' services are enthusiastic about providing quality services, nursing standards, at all levels, but the effectiveness of the service is still problematic. This inequality affects people in remote areas. Health costs are a whole picture of services, medicines, and medical devices. Some places have exorbitant medical costs. In terms of public participation, the public is an important factor. Through public participation, it will clearly establish guidelines for preventing health promotion diseases by address, under the auspices of the public and private sectors (Sukmag, 2018). Therefore, if the above-mentioned elements are balanced, it may cause good public health through cooperation between the government, the private sector, and the public. Health costs are also a major contributor to different health conditions for each area. The factors affecting health by type of Natural Capital is the amount and quality of natural resources that humans can use to live, have been classified. Financial Capital, the financial resources possessed by the population, and can be used. Physical Capital, infrastructure, tools, equipment, manufacturing factors, daily necessities, human capital, skills, learning, knowledge, competence, responsibility and health conditions such as health completeness without pain, torture, various health intelligence, beliefs, attitudes, and behaviors affecting health and Social Capital, social resources, network groups, social relationships, common identities, to

live a life such as social relationships, community strength, co-healing, cultural heritage, and community traditions. Therefore, cost is one fundamental source of health conditions, but today globalization progresses in a wide range of areas. Humans are self-seeking to improve health. Take care of your own health and people around you even if each person has a different cost.

According to the study, ethnic groups are likely to have beliefs, cultures inherited from ethnic groups, although they are helped by relevant public health authorities, but their identity with nature, such as the Akha ethnic group, is well-behaved. White Karens with chronic non-contact disease group risk are shown to have the expression of six health promoting behaviors. Aspect is the aspect of the relationship between practical health responsibility individuals. Exercise behavior. Spiritual development nutrition and stress management showed the most behavioral expression in this area, such as walking to work, and there was an expression of health-promoting behavior about eating breakfast every day. This may be due to Karen people's emphasis on rice from production to baking. Consume and have a culture of rice production to consume.

There is also cleanliness with a change in concept, from the original little shower to oral cleansing and body cleansing by bathing, which strengthens health, does not get sick, and has meditation training, calms the mind by meditating (Manotham, 2019). The health management of the Karen people, originally based on lifestyle, beliefs, rituals, and herbal uses, studied in Praksalavin Grass Learning Center, found an important phenomenon that causes changes in the health of people in the community: (1) changes in food consumption, which changes from natural food to eating acquired from the city, (2) decreases in plants and animals. More than 90 species of forest and water were originally supplied enough for the community to rely on as a seasonal food source for the community. (3) a decrease in crop types in rolling fields due to a shortage of production workers (young people going out to study and working outside the community) and increasing use of lucrative cultivation areas such as cacao peppers. (4) There is a dependence on disease treatment, from hospitalization, community health promotion, and more drugs from community institutions, forest utilization. The utilization of herbaceous plants according to the intelligence of 66 species is classified according to 13 symptomatic treatments of the disease (Toniti, 2018). However, in some areas, it is neglectful to prevent and control diseases such as Karen ethnic groups,

Doi Luang District, Chiang Rai Province, where there is a belief that people who have diabetes even if they eat, prevent diabetes, do not exercise, and do not control food. It adversely affects the body and people around it (Jinathum et al., 2018).

Health care for the elderly, ethnic groups, Yunnan, Museo, Taiyai were found to have relatively good health care behavior, various diet consumption, exercise, rest, and self-care during illness were found elderly people with epilepsy will see a doctor at their appointment. If there are minor illnesses such as headaches, fever, and muscle pain, the method of scratching with coins is used in Yunnan Chinese tribes. Buying paracetamol or herbal medicine to eat or apply on your own, to treat your illness, it is very uncomfortable. Your children or relatives will go to a health promotion hospital in the district hospital, the doctor's clinic, depending on their personal convenience (Promsorn, 2012).

Ethnic people have a unique identity and inheritance of local wisdom, their identities that express artistic, cultural, traditional, physical, linguistic expressions, beliefs, knowledge, and skills. The residential ethnography is classified as being more natural than the urban people, one of the costs that the ethnography enjoys and being close to nature. People and nature's interdependence, or forests, has created various intelligence to respond to problems such as illness. Ethnic people use herbal plants to mix beliefs, cultures to solve health problems, but not only herbal medicine, health promotion, or health prevention. Ethnicity has a long tradition such as promoting health. Conflicts in health care, with herbs and inherited beliefs, do not focus on maintaining and preventing body health by exercising. But it is believed that herbs are healthy tonic that must be drunk regularly, and gardening is already an exercise (Royal Project Foundation, 2021).

So you can see that Marginal people who move in or live in rural areas, along the country line, are exposed to unfairness, have no bargaining power in various rights due to differences in social groups such as ethnic groups, religions, social classes, etc (HR-Guide, 2021). As a result, access to health insurance rights remains a continuing problem for all countries. In Thailand, even though there are policies to manage registration for non-nationals or foreigners to receive health insurance coverage, many people are still not eligible. Borderline health, including border communities, immigrants, people with restrictions on treatment rights, these factors show health such as teenage

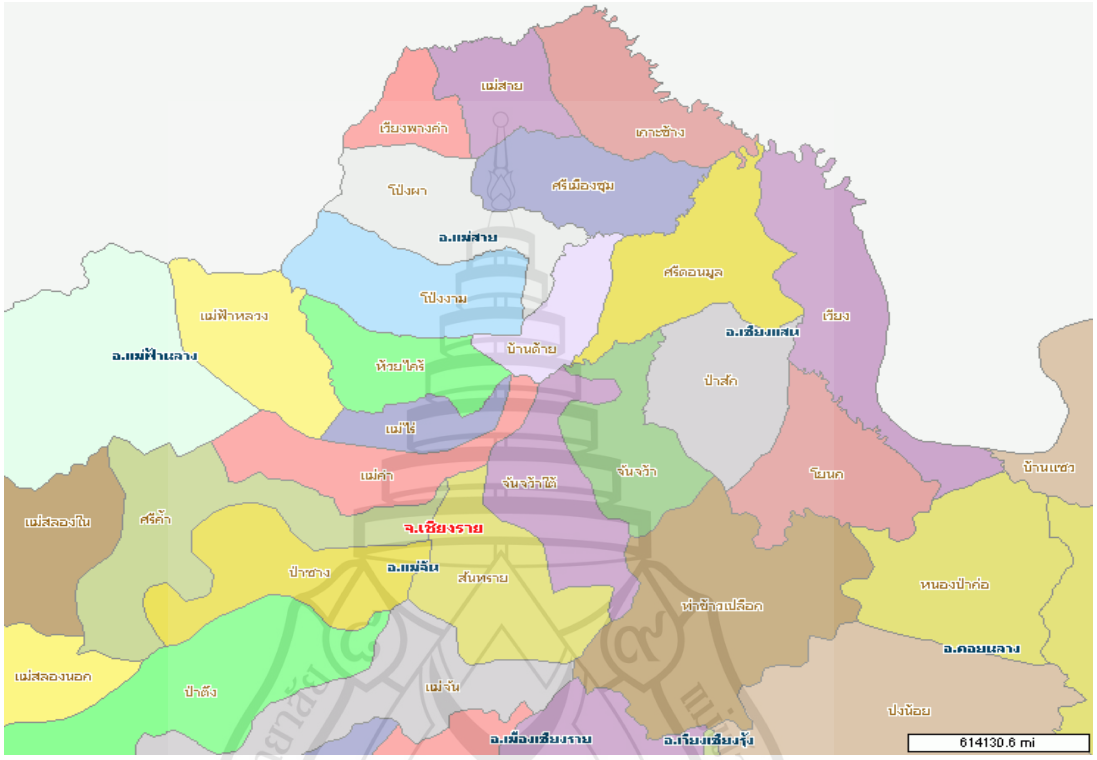
pregnancy. When a mother gives birth to a child's healthcare, lack of understanding of care can lead to various consequences such as malnutrition, lack of adequate breast milk. The body barrier is lowered, and it is easy to affect illness, etc., inaccessible to the right, and it affects getting preventive vaccination in childhood. As a result, it is easy for the body to get sick (Wichaidit et al., 2011).

Not only do the health problems of marginal people not only have access to treatment rights include environmental conditions, difficult acces, or unfair treatment of urban people. These problems affect marginal people economically, socially and healthily. Most of these people's health problems encountered are both contagious and non-contact diseases, such as health effects on children, with low rates of vaccination, causing low immunity, diarrhea, and malnutrition. Effects on women, not screened in women's diseases, risk of cervical cancer, breast cancer or reproductive health care. Health effects on men, chronic alcoholism, HIV or substance abuse. With restrictions on access to treatment rights, some communities choose to neglect their health, or choose to treat it with lifestyle relief, faith, from their own social cultures, such as health care for the thousands of people, to take care of their own health by using ritual therapy, herbal therapy, nutrition therapy. Choice of herb drug according to the Shan state formula for relieving stomachache, heartburn. The Lalong-dang ethnic group in Chiang Rai Province has health care using ritual input therapy, herbal therapy, nutrition therapy, and heat therapy (Arttanuchit & Jeharsae, 2019).

2.6 General Information Wiangphangkham Subdistrict, Mae- Sai District, Chiang Rai Province

Wiang Phang Kham Subdistrict is a subdistrict located in Mae Sai District with a total area of 34 square kilometers by the north adjacent to the Union of Myanmar. There is a wall line at the north side of the temple of Wiang Phan to the east, Mae Sai Friendship Subdistrict Municipality and Si Muang Chum Subdistrict Municipality in the south adjacent to Phong Pha and Phong Ngam Subdistrict, Chiang Ng District, Chiang Rai Province, Chiang Rai Province, Chiang Rai Province, Chiang Rai Province,

Chiang Rai Province, Chiang Rai Province. The district node of Mae Sai Tobacco Station and the west are adjacent to the Union of Myanmar. As shown in Figure 2.1.



Source Wiangphangkham Subdistrict Municipality (2021) and Wiangpangkam Municipal Youth Center (2021)

Figure 2.1 Map of Mae Sai District in Chiang Rai Province

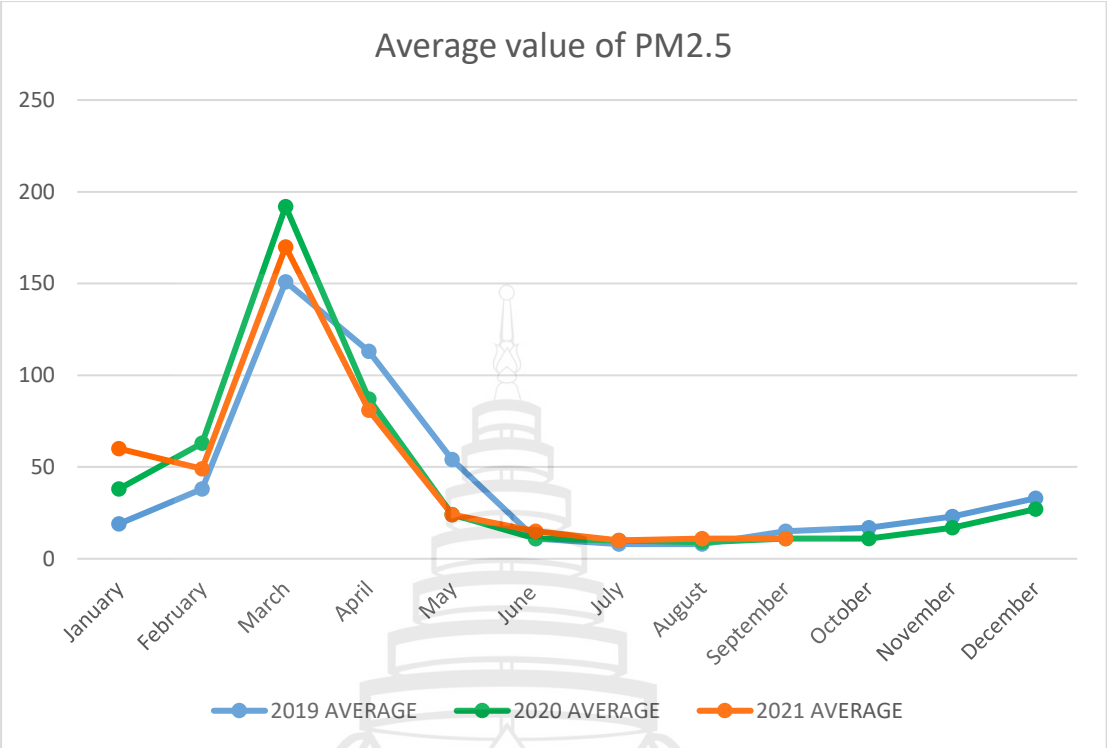
It has terrain characteristics, is a western area, is a mountainous area and a hilly plateau, is used to cultivate field crops, the eastern area is used as a community site and agricultural area, and the terrain characteristics are divided into three seasons: summer, March- May, rainy season, June- October and winter, and November- February, and there are administrative districts with the number of villages in the district. The governance of 10 villages is Mae Sai Village, Doi Ngam Village, Wiang Phan Village, Pa Yang Mai Village, Pa Muang Rung Charoen Village, Pha Mi Village, Huai Nam

Rin Village, Pa Hut Santisuk Village, Pa Muet Suk Samran Village and Pa Yang Pha Taek Village.

In economy, with the area used to cultivate field crops, a total of 4632 rai of agricultural land, cultivated crops include paddy, rapeseed rice, corn. 888, arabica coffee, oolong tea, langjie tea, etc., livestock and dairy farms, poultry farms, and egg farms are farmed, with popular pets being coals, pigs, ducks, ducks, dogs and goats being released by nature. In the Wiangpangkam area, there are large, medium, and small industrial areas and the large industrial complexes are Jiranai Ploy, medium-sized factories. It is a jade salad carving, stone, ball/pork Yeo production and a small factory producing cut alley rice, Chinese confectionery, garlic, and rice mill.

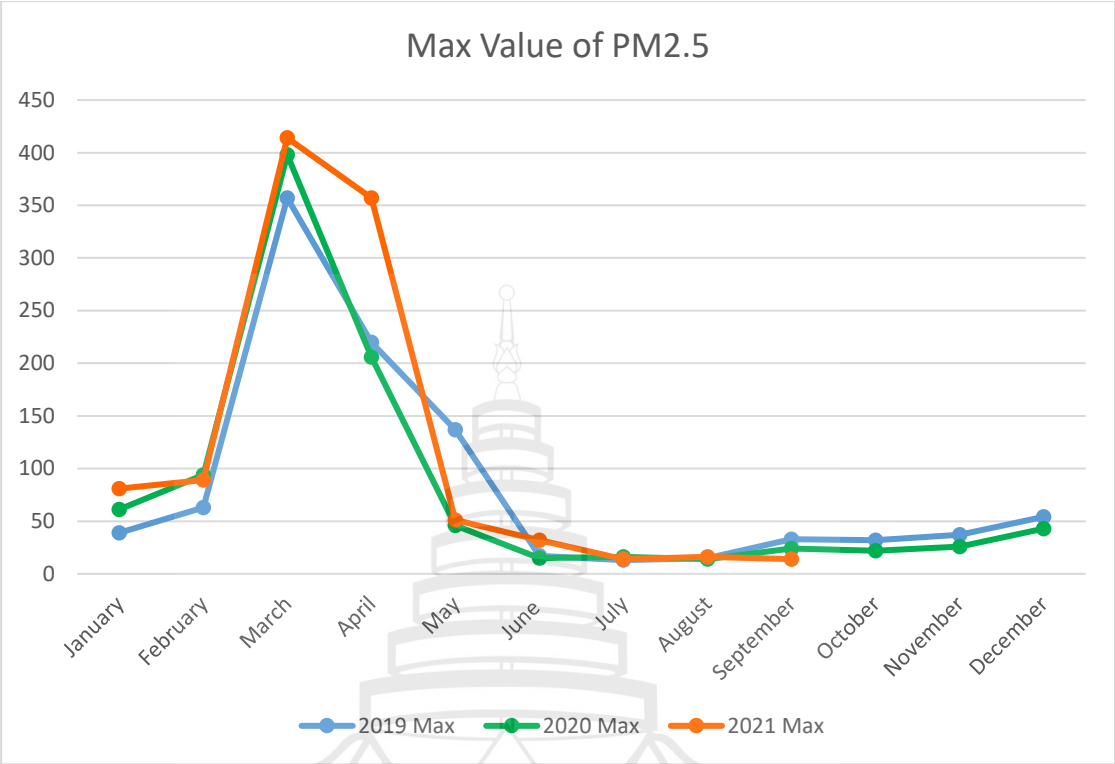
Residents of the Wiangpangkam area respect Buddhism mainly, followed by Christianity, Islam, and ghosts, respectively, in the area with a wide range of attractions, mostly caves such as cave Pha Chom, Pha Mee cave, Lae Mee cave- Hon cave, etc. In addition, as a habitat for ethnic groups, it provides tribal cultural attractions, Ban Pha Mee Mountain Village, located about 10 kilometers from Doi Tung Krat, is a Thai mountain village of Agha tribe. The surrounding area will be mountains, marble, limestone, and an undeveloped area, making it a tourist attraction for tourists who enjoy challenges and a conservation attraction for cultural nature together. However, during the month of smog, PM 2.5 is reported from a fine dust meter installed in Wiangpangkam district. Air pollution is also received every year by Wiangpangkam district, with most of them exposed to smog from both domestic and adjacent Burmese Union countries (Wiangphangkham Subdistrict Municipality, 2021; Wiangpangkam Municipal Youth Center, 2021).

In the area of Wiangpangam County, Chiang Rai Province found that during March and April, it was the highest PM 2.5, with March reaching 357 $\mu g/m^3$, April reaching 220 $\mu g/m^3$, in 2020, March reaching PM2.5 398 $\mu g/m^3$, and April with PM2.5 $\mu g/m^3$, and March with PM2.5 206 $\mu g/m^3$, respectively, in 196 $\mu g/m^3$. And in April, PM2.5 357 $\mu g/m^3$. From the report, a PM 2.5 value was found to be greater than 90 $\mu g/m^3$, indicating that air had a health impact (Air Quality and Noise Management Bureau Pollution Control Department, 2019b, 2020b, 2021b). As shown in Figure 2.2, 2.3.



Source Air Quality and Noise Management Bureau Pollution Control Department (2019b, 2020b, 2021b)

Figure 2.2 Air Quality in the Area of Wiangpangkam District, Mae Sai District, Chiang Rai (2019-2021)



Source Air Quality and Noise Management Bureau Pollution Control Department (2019b, 2020b, 2021b)

Figure 2.3 Air Quality (Highest Level) in the Area of Wiangpangkam District, Mae Sai District, Chiang Rai Province (2019-2021)

If the PM 2.5 value in 2019-2021 is compared, the average value is found to be high in March-April, with the highest level in 2020, and from the highest PM 2.5 value in 2019-2021 it is found to be high in March-April, where PM 2.5 in 2021 is the year with the highest PM 2.5 value. That means the March-April period is still the period. It's a critical period, the period that affects the health of people in the community the most.

2.7 Other Relate Research

Signs and symptoms of acute respiratory infections in children are found to be very common in rural areas, low-income areas or developing areas, and the cause of early illness and death is pneumonia. The correlation of pneumonia among children under the age of 5 is investigated, which is most common under the age of 2 from dividing the age range into 3 periods of 0-11 months, 12-23 months, and 24-59 months (Hassen et al., 2020; Sultana et al., 2019; Teeratakulpisarn et al., 2012) According to research, in males, there is a higher rate of acute respiratory infections than in females (Savitha & Gopalakrishnan, 2018; Sultana et al., 2019).

In which the mother or caregiver is involved, if the mother has the knowledge, education level, and age over 35 are significant for acute respiratory infections. If the mother has education level, read, write, understand, and know prevention, surveillance, but in the same way, most mothers or viewers older than 35 years of age carry children with them at all times are risk of respiratory infection easier (Hassen et al., 2020; Merera, 2021; Sultana et al., 2019)

In Ethiopia and some countries, it has been found that the use of fuel, an energy source for cooking, overcrowding, malnutrition, and the risk of pneumonia should be improved, biofuel consumption should be reduced, adequate and balanced food intake, and breastfeeding should be a preventive treatment. In the early stages of acute respiration (Hassen et al., 2020; Savitha & Gopalakrishnan, 2018; Simoes et al., 2006; Sultana et al., 2019).

Air pollution is another factor that affects body health, according to a study on the relationship of respiratory infections and air pollution, the rate of increase in pneumonia and colds is related to an increase in PM 2.5 dust values, and the burden of disease is 50-100% with a greater risk of lower respiratory infections related to an increase of 50-150 mg/m3 (Croft et al., 2019). Air pollution contributes to obesity. According to a study, exposure to air pollution causes overweight in children, affects the immune system in the body, and affects the metabolism in the body because of inflammation in fat tissues. Weight caused by exposure to air pollution affects other

systems, such as inflammation. Encephalitis, cardiovascular disease, respiratory system disease and cancer (Parasin et al., 2021).

Finding the root cause of acute respiratory infections is preventing and correcting the root cause, although some factors can be controlled only when knowledge acquisition creates awareness of the importance of care, to prevent chronic diseases or increasing severity, and to reduce premature incidence and mortality. The age that should be cared for is because the child will grow and turn into an age that is the strength of society in the future. Even now, children are still vulnerable. Exposure to air pollution poses a major health threat to children, including co-creating health sustainability, reducing health problems caused by exposure to air pollution is another major goal for Thailand and the world as defined by the World Health Organization (WHO, 2018a).

CHAPTER 3

MATERIALS AND METHODS

The research methods of this study aimed to find a relationship between air pollution and the occurrence of acute respiratory infections among children under five years of age in the marginalized community of Mae Sai District, Chiang Rai Province. The details are as follows:

3.1 Study design

3.2 Study site

3.3 Study flow

3.4 Eligible Population

3.5 Sample Size

3.6 Research Instruments

3.7 Determination of the validity and reliability of research instrument

3.8 Data collection

3.9 Statistical Analysis

3.10 Ethical consideration

3.1 Study Design

A community-based cross-sectional study. Was conducted in Mae Sai district.

3.2 Study Site

Study was set in Wiangphangkham Subdistrict, Mae-Sai District, ChiangRai Province. Because Tambon Wiang Pang Kham has a PM2.5 monitoring station (Figure 2.1.) and exceeds the standard for particulate matter every year. In Wiangphangkham

Subdistrict have 10 village total 707 children Male 389, female 318 were Mae Sai Village 117 children, Doi Ngam Village 117 children, Wiang Phan Village 74 children, Pa Yang Mai Village 44 children, Pa Muet Rung Charoen Village 48 children, Pha Mi Village 12 children, Huai Nam Rin Village not had children age under the five, Pa Muet Santisuk Village 59 children, Pa Muet Suk Samran Village 107 children, Pa Yang Pha Taek Village 129 children.

3.3 Study Flow

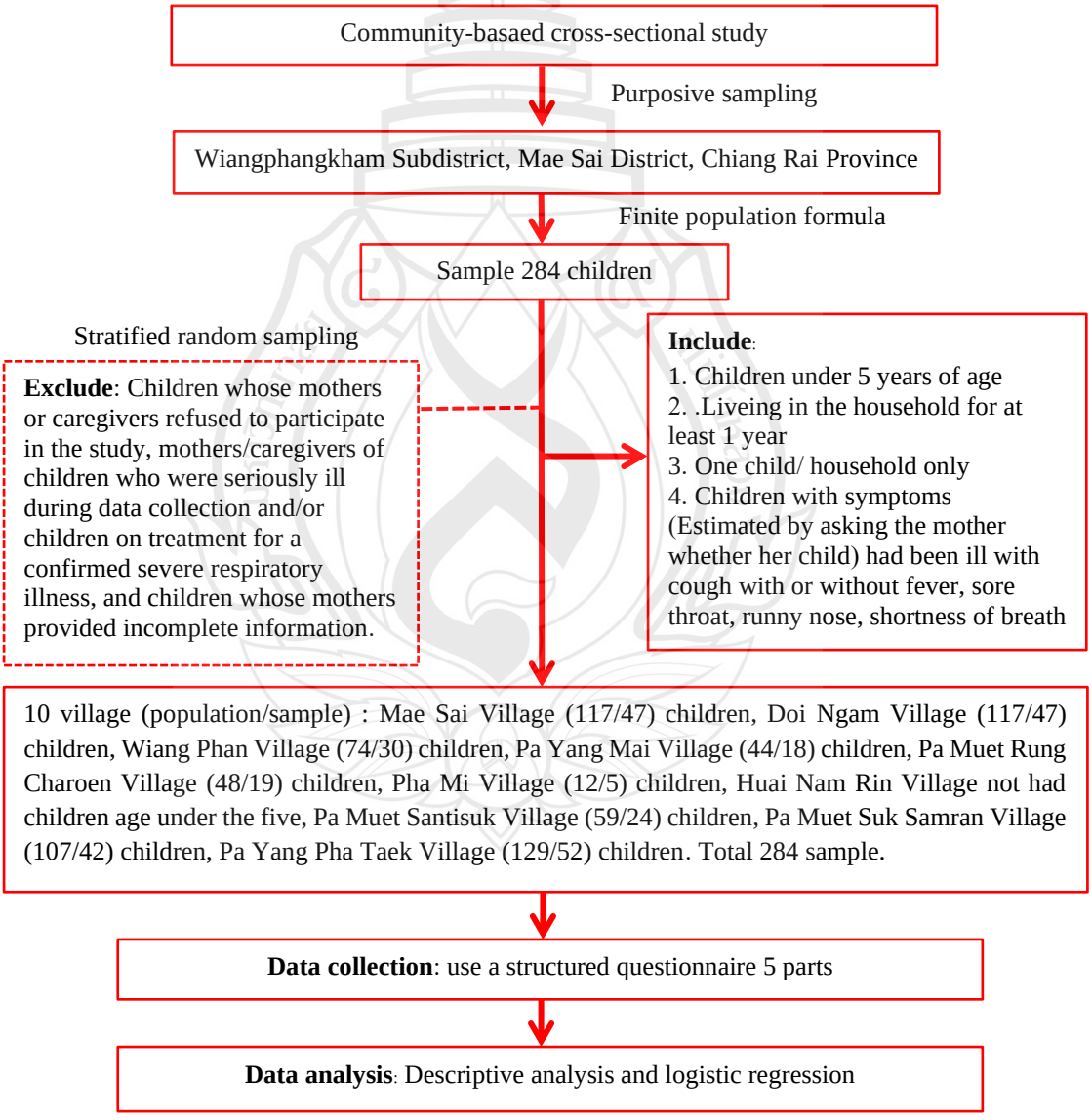


Figure 3.1 Study Flow

3.4 Eligible Population

3.4.1 Inclusion Criteria

3.4.1.1 Children under 5 years of age

3.4.1.2 Living in the household for at least 1 year

3.4.1.3 One child/ household only

3.4.1.4 Children with symptoms (estimated by asking the mother whether her child) had been ill with cough with or without fever, sore throat, runny nose, shortness of breath.

3.4.2 Exclusion Criteria

Children whose mothers or caregivers refused to participate in the study, mothers/caregivers of children who were seriously ill during data collection and/or children on treatment for a confirmed severe respiratory illness, and children whose mothers provided incomplete information.

3.5 Sample Size

The sample size was determined using the single population proportion formula considering the assumptions of

$$n = \frac{p(1-p)}{\frac{e^2}{Z^2} + \frac{p(1-p)}{N}}$$

Where n is number of population groups, *p* i was estimate of the prevalence of acute respiratory infection for this study we assumed a prevalence of acute respiratory infection was around 73%(Teeratakulpisarn et al., 2012), e is margin of error (5.0%). Z is the standard normal variable value at (1-α) % confidence level (α is 0.05 with 95% CI [confidence interval], Z = 1.96), N was population number for this study N= 707 people. The final sample size was determined to be 237 (+20%) ≈ 284 the sampling method used stratified random sampling.

Table 3.1 Sample Size

Village	Population	Sample
Mae Sai Village	117	47
Doi Ngam Village	117	47
Wiang Phan Village	74	30
Pa Yang Mai Village	44	18
Pa Muet Rung Charoen Village	48	19
Pha Mi Village	12	5
Huai Nam Rin Village	0	0
Pa Muet Santisuk Village	59	24
Pa Muet Suk Samran Village	107	42
Pa Yang Pha Taek Village.	129	52
Total	**707**	**284**

3.6 Research Instrument

We used a structured questionnaire in this research, which the researcher created in accordance with the incidence factors and symptoms of acute respiratory infections and air pollution was divided into 5 parts. part1 Personal information, part 2 Source PM 2.5 and environment, part 3 exposure PM 2.5, part 4 Prevention and care and part 5 Symptoms and signs of respiratory infections in children within a 2 month. The details are as follow:

Part 1 Personal information divided 6 parts include (1) Age of child; had 3 ranges of age (Hassen et al., 2020) are 0-11 months, 12-23 months, and 24-59 months. (2) Sex of child (3) Age of mother or care giver; divided into three ranges of age were 15-24 years, 25-34 years and 35 or above. (4) Education of mother or care giver; divided in to 3 level were unable to read& write, able to read& write and Primary level or above. (5) Family size; equal to or less than 5 people, more than 5 people. (6) Nutritional status & Medical condition; vitamin A supplement, zinc supplement, Pneumococcal Conjugate Vaccine (PCV), Covid-19 vaccine, Tuberculosis Conjugate Vaccine (BGC),

status of vaccine, history ARI in child, history of congenital heart disease in child, history of HIV in child, history of TB in child, history of ARI in family, acute malnutrition using MUAC It is measured by a researcher, health officer or data collector by using a tape measure

Part 2 Source of PM 2.5 and environment include (1) Source of energy for cooking, (2) cigarette smoker, (3) burning trash, (4) Used spray in home, (5) window in kitchen and (6) Type of house. (7) Divided proportion in house

Part 3 Exposure of PM 2.5 included (1) Exposure while cooking and duration of exposure. (2) Exposure while who smoking and duration of exposure. (3) Exposure while burning outside and duration of exposure. (4) Exposure while used spray in house and duration of exposure. (5) Duration when child outside and (6) Duration when child in house (inside).

Part 4 Prevention and care of child include (1) behavior of used make for protect. (2) Type of mask (3) Number of mask usage and (4) hand washing after did activity outside (5) Hygiene; Sanitation facility

Part 5 sign and symptoms of acute respiratory infection in children in 2-month period include (1) cough (with / without fever). (2) Breath fast/ breath short. (3) Breath difficultly. (4) Wheezing and (5) Sore throat.

3.7 Determinate of Validity and Reliability of Research Instrument

The researchers created a questionnaire with the following procedure.

1. studied, concepts, related theories, and collect relevant information. From books, documents, articles, and related research, by understood the contents to be researched to be used to create a questionnaire.

2. Created a questionnaire related to the factors of PM 2.5 and symptoms of acute respiratory infection in children, investigated the contents of the questionnaire, whether covered the purpose, then consulted with the advisor, checked it, and revised it according to the advisor’s advice.

3. Took the questionnaire revised according to the advice of the advisor and submitted it to three supervisor persons to verify the instrument validity and the criteria for considering the opinion score were set as follows.

+1 = Congruent with clear understanding.

0 = Uncertain or not sure whether item related to the study.

-1 = Not congruent and not related to study.

The researchers then analyzed it to found the index of item-Objective conclusion: IOC, where acceptable values had values equal to or above 0.50 (Angsuchoti et al., 2014) with the following formula.

$$IOC = \frac{\sum R}{N}$$

IOC = Item-Objective Congruence Index

$\sum R$ = Total points of each supervised

N = Number of supervised

IOC of study has one question scored = 0.67, another question scoured = 1

4. After undergoing consideration from supervisors, brought it to establish reliability. A pre-test was conducted using 5% sample size of the total study sample in Wiangphangkham Subdistrict, was 30 sample. And the results were analyzed for Cronbach's alpha coefficient, The reliability was presented with Cronbach's alpha = 0.73, which was accepted for use the study

3.8 Data Collection

The questionnaire was adopted in the English version, translated to Thai or the local language, and then translated back to English to ensure consistency. The data collectors were trained to focus on the survey instrument, physical examination, and measuring the mid-/upper-arm circumference.

The data collectors, who were researchers and public health officers, administered face-to-face interviews with mothers and/or primary caregivers, observed

participants' housing and environmental conditions, and conducted physical examinations of the children.

3.9 Data Analysis

All data will be reviewed and checked for completeness. Completed questionnaires will be coded and entered Epi-Data version 3.1. First, a descriptive analysis of frequency distributions will be done for all variables. Descriptive present frequency, mean, maximum, minimum standard deviation and rage was used to explain characteristic of subject. Categorical data was present in percentage.

Chi-square and logistic regression were used to test for associations between variable at significance at $\alpha = 0.05$.

3.10 Ethical Considerations

The ethical approval letter was obtained from Mae Fah Luang University Ethical Committee (MFU COA:112/2022). Informed consent was obtained from mothers/caregivers. Children who were sick during data collection were linked to the nearest health facility for further treatment. They were assured that their information would not be used for purposes other than scientific research and the participation was voluntary and that they could withdraw from the interview at any time for whatever reason. Confidentiality was maintained by avoiding possible identifiers.

CHAPTER 4

RESULTS

This chapter presented the results of the data analysis. The first section presented the basic information of each variable. The second section compared the signs and symptoms of acute respiratory infection in the PM 2.5 and without PM 2.5 periods. The final section presented the association between air pollution and the signs and symptoms of acute respiratory infection in the PM 2.5 period.

4.1 Basic Information of Each Variable through Descriptive Analysis

4.1.1 Overview of the Study Participants' Demographics and Various Health-related Factors

The studied encompassed 171 participants and offered significant insights into their demographics and health-related factors (Table 4.1). Notably, the gender distribution of the children was balanced, with 57.3% male and 42.7% female. The children's average age was 2.50 years, and their mothers or caregivers had a mean age of 34 years. Educational diversity among the mothers was observed, with varying levels of education, ranging from being unable to read and write to holding bachelor's degrees. The most of educate level was Able to read and write (31.0%). Family size leaned towards larger households, with 78.9% having more than four members.

Vaccination statuses varied, with most children had full vaccine (67.8%) had vitamin A supplementation intake (52.6%) zing supplementation intake (73.1%) received the Pneumococcal Conjugate Vaccine (40.9%) and Tuberculosis Conjugate Vaccine (56.7%). the most children do not have Covid-19 vaccine (82.5%). There's more than children have not vaccine vitamin A supplementation intake (24.0%) zing supplementation intake (19.3%) not received the Pneumococcal Conjugate Vaccine

(33.3%) and Tuberculosis Conjugate Vaccine (26.9%). And children have Covid-19 less than children get Covid-19 (11.1%).

Breastfeeding was common, with a median duration of 6 months. Additionally, history of health issues such as ARI and congenital heart disease in children was recorded. Most mothers had received tetanus toxoid injections, and a considerable percentage had received multiple doses. In Acute malnutrition using the mid-upper arm circumference was normal (16.2 cm.) Form standard children 1 year old is 14 cm and increase 1 cm/ year until 5 years. So normal value is more than 13.5 cm. If 12.5-13.5 was started to have a lack of protein and energy. And if less than 12.5cm had a lack of protein and energy.

Table 4.1 Socio-demographic Factors of Mother/Caregiver and Child

Characteristics	**Study participants (n = 171)**	
	No.	**%**
Gender of Child		
Male	98	57.3%
Female	73	42.7%
Age of child (Years) Mean±SD	(2year) 2.50 ±1.47	
Age of mother/caregiver (Years) Mean±SD	(34year) 34.4 ±11.1	
Education of mother/caregiver		
Unable to read and write.	35	20.5%
Able to read and write.	53	31.0%
Primary school or above	17	9.9%
Secondary school or above	50	29.2%
Bachelor’s degree or above	13	7.6%
Not remember	3	1.8%

Table 4.1 (continued)

Characteristics	Study participants (n = 171)	
	No.	**%**
Number of family members		
Less than 4	36	21.1%
More than 4	135	78.9%
Vitamin A supplementation intake		
Have	90	52.6%
Do not have.	41	24.0%
Not remember	40	23.4%
Zinc supplementation intake		
Have	125	73.1%
Do not have.	33	19.3%
Not remember	13	7.6%
Pneumococcal Conjugate Vaccine		
Have	70	40.9%
Do not have.	57	33.3%
Not remember	44	25.7%
Covid-19 Vaccine		
Have	19	11.1%
Do not have.	141	82.5%
Not remember	11	6.4%
Tuberculosis Conjugate Vaccine		
Have	97	56.7%
Do not have.	46	26.9%
Not remember	28	16.4%
Status of vaccination		
Fully vaccination	116	67.8%
Incomplete vaccination	52	30.4%
Not remember	3	1.8%

Table 4.1 (continued)

Characteristics	Study participants (n = 171)	
	No.	**%**
How many months of breast feeding Median (IQR)	6.00(12-3)	
Kind of milk		
Breast milk	115	67.3%
Dry milk power	23	13.5%
Mixed milk	33	18.7%
Don’t know.	1	0.6%
Does a mother have tetanus?		
Toxoid (TT) injection?		
Yes	149	87.1%
No	22	12.9%
How many times does mother has tetanus toxoid?		
Never	26	15.2%
1 time	33	19.3%
2 times	92	55.8%
3 times	20	11.7%
Wearing of child (months) Median (IQR)	2(12-0)	
History of ARI in child		
Yes	53	31%
No	118	69%
History of congenital heart disease in child		
Yes	2	1.2%
No	169	98.8%
History of HIV in child		
Yes	0	0%
No	171	100%

Table 4.1 (continued)

Characteristics	Study participants (n = 171)	
	No.	**%**
History of TB in child		
Yes	0	0%
No	171	100%
History of ARI in family		
Yes	141	82.5%
No	30	17.5%
Acute malnutrition using the mid-upper arm circumference (MUAC; cm.) Mean±SD	16.2±2.11	

4.1.2 Overview of the Study Participants' Environmental and Housing Factors

When it came to the source of energy for food cooking, 46.2% used biomass fuels, 45.0% used clean fuels, and 8.8% relied on kerosene (Table 4.2). Additionally, 40.4% of the participants were cigarette smokers, while 59.6% were non-smokers. The average time spent cooking per session was 17.7 minutes, with a wide standard deviation of 47.0 minutes. Interestingly, only 4.1% of participants burned trash outside, averaging 0.731 minutes per session. In terms of indoor air quality, 30.4% used cleaning and deodorizing sprays in their houses, with an average use time of 9.95 minutes. Most of the houses had windows in the kitchen (87.1%). House types varied, with 55.0% having cement structures, 43.3% made of wood, and 1.8% a combination of wood and cement. Lastly, all the houses (100.0%) had a characteristic division in proportion, indicating that the kitchen, bathroom, and bedroom were separated in each case.

Table 4.2 Environmental and Housing Factors

Variables	Study participants (n = 171)	
	No.	**%**
What source of energy for food cooking?		
Biomas fuels	79	46.2%
Clean fuels	77	45.0%
Kerosene	15	8.8%
Are there cigarette smokers?		
Yes	69	40.4%
No	102	59.6%
How many minutes at a time? (minutes/time) Mean±SD	17.7±47.0	
Do you burn trash outside?		
Yes	7	4.1%
No	164	95.9%
How many minutes at a time? (minutes/time) Mean±SD	0.731±3.97	
Do you use products that are cleaning spray, deodorizing spray in the house?		
Yes	52	30.4%
No	119	69.6%
How many minutes at a time? (minutes/time) Mean±SD	9.95±46.6	
Does the kitchen have a window?		
Yes	149	87.1%
No	22	12.9%
Type of house		
Cement	94	55.0%
Wood	74	43.3%
Wood and cement	3	1.8%

Table 4.2 (continued)

Variables	Study participants (n = 171)	
	No.	**%**
Is the house characteristic divided in proportion, such as whether the kitchen, bathroom, and bedroom are separated?		
Yes	171	100.0%
No	0	0.0%

4.1.3 Overview of the Study Participants' Exposure to Indoor and Outdoor Air Pollution

Not able findings include that a significant proportion of participants (44.4%) place children outside the cooking area while preparing meals, with an average duration of approximately 28 minutes (Table 4.3). Similarly, most children are kept away from smoking areas (53.8%), with minimal exposure time (0.442 minutes). Most participants have children inside the house when burning trash (90.1%), although they spend very little time close to the burning area (0.0292 minutes). Furthermore, most participants did not keep their children close when used spray cleaners or deodorants (60.8%).

On average, children spend around 2.75 minutes outdoors and approximately 21.2 minutes indoors per day. These statistics highlight the diverse childcare practices and the varying levels of exposure to potentially harmful situations within the household.

Table 4.3 Exposure to Indoor and Outdoor Air Pollution

Variables	Study participants (n = 171)	
	No.	**%**
While cooking, where did you put the child?		
Outside the house/Open space	46	26.9%
Outside the cooking area (outside the kitchen)	76	44.4%
Inside the kitchen	47	27.5%
Hold it/It's behind mom.	1	0.6%
Not remember	1	0.6%
How long does the child stay close to you while you are cooking? (minutes/time) Mean±SD	28.1±16.2	
Where is the child while someone smokes in the house?		
Outside the smoking area	50	29.2%
Outside the house (open space)	28	16.4%
Not smoking	92	53.8%
Not remember	1	0.6%
How long has the child been around someone who smokes? (minutes/time) Mean±SD	0.442±2.61	
During burning trash, where was the child?		
Outside the burning area (inside house)	13	7.6%
No burning trash.	154	90.1%
Not remember	4	2.3%
How long does the child stay close to burning area? (minutes/time) Mean±SD	0.0292±0.275	
Where is the child when you use a spray cleaner or deodorant in the house?		
Stay close spray area.	1	0.6%
Outside the spray area	29	17.0%
Outside the house/Open space	30	17.5%

Table 4.3 (continued)

Variables	Study participants (n = 171)	
	No.	%
Not used	104	60.8%
Not remember	7	4.1%
How long does the child stay close to the area that you use a spray cleaner or deodorant in the house? (minutes/time) Mean±SD	1.64±6.73	
How long does the child spend time outside of the house? / day (e.g. Activities, jogging…) (minutes/time) Mean±SD	2.75±2.97	
How long does the child spending time inside of the house? / day (e.g. playing with toys, watching TV, sleeping…) (minutes/time) Mean±SD	21.2±2.97	

4.1.4 Overview of the Study Participants' Prevention and Care of Child

First, nearly all children (98.8%) did not use a mask when went outside, with only 1.2% used masks (Table 4.4). Second, the majority (98.8%) use no more than one mask per day. Third, concerned hand hygiene, 77.8% of the children always washed their hands after outdoor activities, while 17.5% did so 1-2 times and only 1.2% never did.

Finally, the sanitation facilities vary, with 74.9% had in-house toilets with adequate sewage disposal, 23.4% had in-house toilets without adequate sewage disposal, and only a small percentage used public/community toilets, either with or without adequate sewage disposal (1.2% and 0.5%, respectively). These data provided valuable insights into children's behavior and access to sanitary facilities in the study population.

Table 4.4 Prevention and Care of Child

Variables	Study participants (n = 171)	
	No.	%
Does the child use a mask when going outside?		
Yes	2	1.2%
No	169	98.8%
How many masks that the child used/day?		
0 piece	169	98.8%
1 piece	2	1.2%
2 pieces	0	0%
3 pieces	0	0%
4 pieces	0	0%
5 pieces	0	0%
How many times that the child wash his/her hands after doing the activity outside/day?		
Always (every time)	133	77.8%
Sometimes (1-2 times)	30	17.5%
Never	2	1.2%
Not remember	6	3.5%
Sanitation facility		
In-house toilet with adequate sewage disposal	128	74.9%
In-house toilet without adequate sewage disposal	40	23.4%
Public/community toilet with adequate sewage disposal	2	1.2%
Public/community toilet with not adequate sewage disposal	1	0.5%

4.1.5 Air Quality Index (AQI) at Maesai District, Chiangrai, Thailand

Figure 4.1 provided important air quality data for PM2.5, PM10, O3 (ozone), and NO2 (nitrogen dioxide) levels for the months of August to April in 2022 and 2023.

Notably, there were a noticeable increase in PM 2.5 levels from August 2022 to April 2023, with a significant spike in February 2023. PM10 levels also display a similar upward trend. Ozone (O3) levels tend to vary, with the highest levels occurring in March 2023. Nitrogen dioxide (NO2) shown fluctuations over the months, with the highest levels in January 2023.This data was indicative of seasonal and potentially environmental factors affecting air quality in the region, with a harmful pollutant.

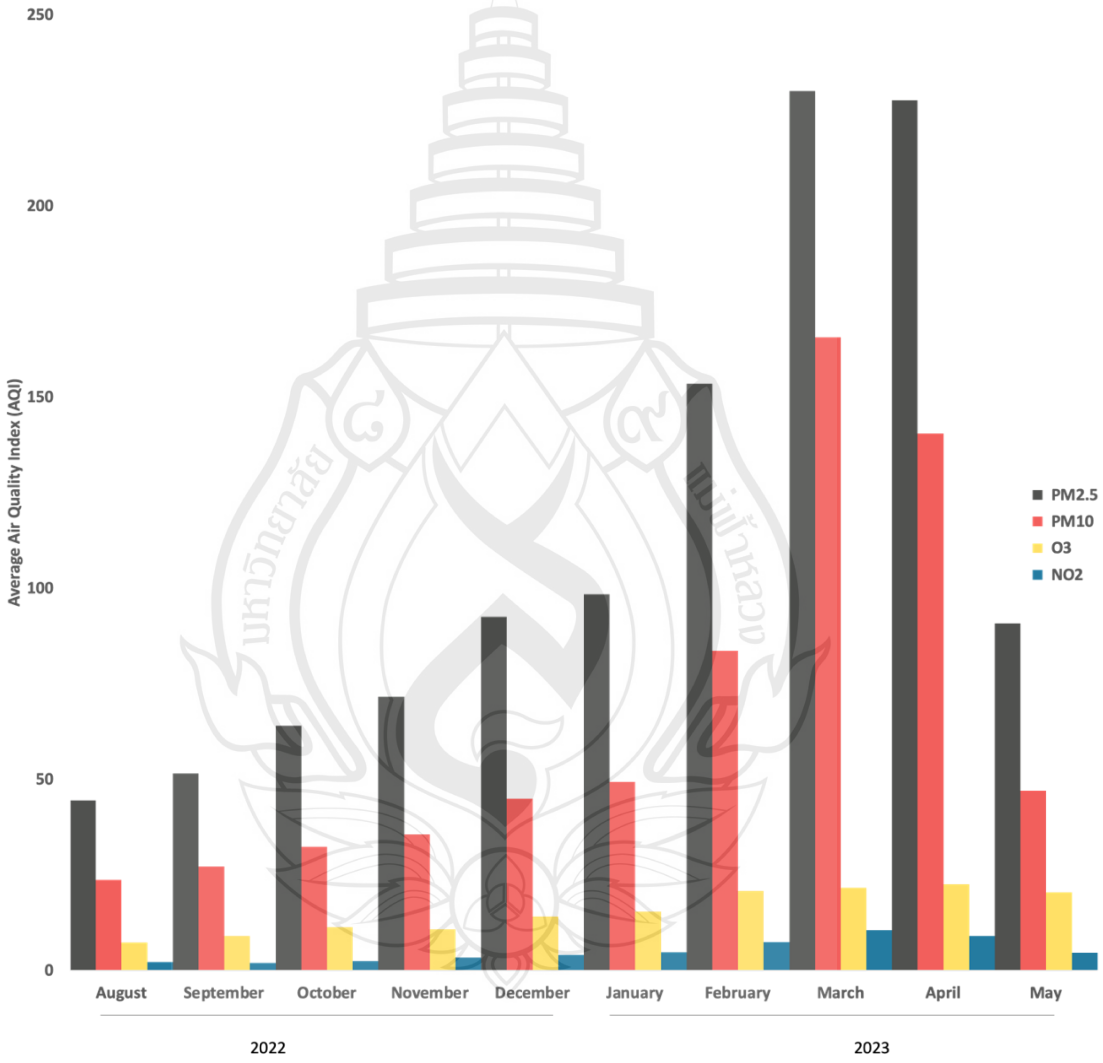


Figure 4.1 Monthly Average Air Quality Index (AQI) at Maesai District, Chiangrai, Thailand

4.2 Result Compares Sign and Symptom of Acute Respiratory Infection in PM 2.5 and without PM 2.5 Period

Table 4.5 The Association between PM 2.5 and Sign and Symptom of Acute Respiratory Infection (n=171)

Sign & symptom	PM 2.5 (%)		χ-test	df	p-value
	With	Without			
Cough (with or without fever)					
Yes	118 (69.0)	62 (36.2)	36.78	1	<0.001*
No	53 (30.9)	109 (63.7)			
Breathe fast/short					
Yes	93 (54.3)	13 (7.6)	87.5	1	<0.001*
No	78 (45.6)	158 (92.3)			
Difficulty in breathing					
Yes	96 (56.1)	19 (11.1)	77.6	1	<0.001*
No	75 (43.8)	152 (88.8)			
Wheezing					
Yes	73 (42.6)	9 (5.2)	65.7	1	<0.001*
No	98 (57.3)	162 (94.7)			
Sore throat					
Yes	72 (42.1)	31 (18.1)	23.3	1	<0.001*
No	99 (57.8)	140 (81.8)			

Note *Significance at $\alpha = 0.05$

From Table 4.5. The study found statistically significant association ($p < 0.05$) between air pollution and symptom groups. Cough (with or without fever) was significantly associated with PM 2.5 dust ($p < 0.05$), Breathe fast/short was significantly associated with PM 2.5 dust ($p < 0.05$), Difficulty in breathing was significantly associated with

PM 2.5 dust ($p < 0.05$), wheezing was significantly associated with PM2.5 dust ($p < 0.05$), and sore throat was significantly associated with PM2.5 dust ($p < 0.05$).

4.3 Result of Air Pollution Association Sign and Symptom of Acute Respiratory Infection in PM 2.5 Period

Table 4.6 Result of Air Pollution Association Sign and Symptom of Acute Respiratory Infection in PM 2.5 Period

Variables	OR	95% CI	p-value
Cough			
Without PM 2.5.	1		
With PM 2.5	3.91	2.50-6.14	<0.001*
Breathe fast/short			
Without PM 2.5	1		
With PM 2.5	14.4	7.64-27.50	<0.001*
Difficulty in breathing			
Without PM 2.5	1		
With PM 2.5	10.2	5.82-18.01	<0.001*
Wheezing			
Without PM 2.5	1		
With PM 2.5	13.4	6.42-28.00	<0.001*
Sore throat			
Without PM 2.5	1		
With PM 2.5	3.28	2.01-5.38	<0.001*

Table 4.6 presents the results of air pollution association sign and symptom of acute respiratory infection in PM 2.5 period. The table provides Odds Ratios (OR)

along with their corresponding 95% confidence Intervals (CI) and p-values for each factor under consideration. The study found during with PM 2.5 period, children had cough 3.91 times more than without PM 2.5 period. (OR=3.91,95**%**CI=2.50-6.14, p< 0.001), during with PM 2.5 period, children had breathed fast or short 14.4 times more than without PM 2.5 period. (OR=14.4,95**%**CI=7.64-27.50, p< 0.001), during with PM 2.5 period, children had difficulty in breathing 10.2 times more than without PM 2.5 period. (OR=10.2,95**%**CI=5.82-18.01, p< 0.001), during with PM 2.5 period, children have wheezing 13.4 times more than without PM 2.5 period. (OR=13.4,95**%**CI=6.42-28.00, p< 0.001) and during with PM 2.5 period, children have sore throat 3.28 times more than without PM 2.5 period. (OR=3.28,95**%**CI=2.01-5.38, p< 0.001)

CHAPTER 5

DISCUSSION AND CONCLUSION

This chapter present discussion, recommendation conclusion and limitation. The aimed to studied associated air pollution 2.5 with sing and symptom of acute respiratory infection in children under 5 years. The data conducted from August 2022-May 2023

5.1 Discussion of the Findings

The study's finding from data collected indicates that childcare practices significantly impact the occurrence of respiratory infections in children. Mothers or caregivers with higher levels of education demonstrate a greater understanding and awareness of childcare, resulting in improved care for children. This includes increased vigilance regarding children's symptoms and providing timely care, thereby reducing the risk of infections or prolonged exposure to pollutants. This finding aligns with previous research conducted by Fathmawati et al. (2021), Windi et al. (2021), and Gothankar et al. (2018) on poor knowledge in hygiene, as well as research in Cameroon by Tazinya et al. (2018).

A history of respiratory infections in the family or in the child's past is associated with a higher likelihood of the child contracting respiratory infections, especially those with rapid breathing or wheezing. These children are more likely to experience severe symptoms, and some may be at risk of developing pneumonia or bronchiolitis from prolonged exposure to pollutants same (Beletew et al., 2020). Nutritional intake is also an important part, including being fully vaccinated. It is associated with Acute Respiratory Infection in children. (Alamneh & Adane, 2020) From the table, dietary intake affects the occurrence of acute respiratory infection. If a child is exposed to complete nutrients, it will increase the child immune system.

Because children may be at risk of exposure to air pollution even if they are not in smog period. If have lower value of malnutrition base on MUAC its association with wheezing (Gothankar et al., 2018).

Children under the age of 5 are considered a high-risk group and should be closely monitored by parents. Research has indicated that fast or short breathing was the most prevalent symptom, with children experiencing 14.4 times more fast or short breathing in the presence of PM 2.5 compared to those without such exposure. This suggests that short-term exposure to PM 2.5, as well as long-term exposure leading to dust accumulation, increases the likelihood of respiratory symptoms. The use of certain cooking materials, such as biomass fuels derived from living organisms like plants and animals, has been associated with an increased risk of acute respiratory infections in children. Burning biomass, like other solid fuels such as coal, releases significant quantities of harmful substances into the air, including particulate matter, nitrogen oxides, carbon monoxide, sulfur dioxide, lead, mercury, and various other dangerous airborne pollutants. In some cases, wood is used as a fuel source, which could affect the incidence of acute respiratory infections in children (Beletew et al., 2020).

The relationship between respiratory infections and air pollutants is clear and arises from the mechanism of respiratory infections when the body is exposed to foreign substances. The symptom of “dust-induced coughing” is typically characterized by throat irritation, including scratchiness or soreness, nasal irritation, dry coughing, and occasional sneezing. These are protective mechanisms employed by the body to expel foreign particles. When fine dust particles are inhaled, they can trigger throat irritation, prompting coughing to remove these particles. However, prolonged exposure of children to high levels of pollutants can exacerbate coughing symptoms, leading to inflammation in the body, which can result in fever or more serious conditions such as bronchitis.

Breathing fast or short is an indicator of abnormal lung function. The lungs are pivotal in the body’s gas exchange process. When the lungs are compromised in size or inflamed, they must work harder to effectively exchange gases. Consequently, prolonged exposure of children to accumulated pollutants results in the retention of toxins in the body. This impacts the lung regions responsible for receiving oxygen, leading to insufficient oxygen intake. Despite the heightened and rapid breathing, the

frequency of breaths can decrease carbon dioxide levels in the blood, leading to respiratory alkalosis. This can cause significant vasoconstriction in the blood vessels supplying various body parts, particularly the brain. Moreover, hemoglobin's strong affinity for oxygen reduces the release of oxygen to tissues as blood flow diminishes. Breathing fast or short has long-term implications for children, potentially increasing their risk of developing asthma in the future.

Long-term exposure to air pollutants impacts vital organs. In addition to abrupt symptoms like coughing or fast breathing, there can also be difficulty breathing, which often occurs in children or the elderly. This difficulty arises from compromised gas exchange in the lungs or injury to the lower airways, leading to wounds or ulcers. Some may exhibit severe symptoms such as wheezing or fast breathing, indicating inflammation and constriction in parts of the respiratory system, possibly due to various diseases or abnormalities. Prolonged exposure of children to toxins can result in serious illnesses.

Regardless of exposure duration, children react to toxins or foreign substances with symptoms like coughing, sneezing, and throat irritation. These reactions can escalate to acute bronchitis, among other conditions. For instance, studies have revealed a link between lung function and exposure to air pollutants, both short-term and long-term (Zhang et al., 2023; Zhou et al., 2023).

5.2 Conclusion

Research has demonstrated that during periods of air pollution or when PM 2.5 levels exceed standard values, children are at a higher risk of developing signs and symptoms of acute respiratory infections compared to usual conditions. Children under the age of 5 are particularly susceptible and require close monitoring. Caregivers, including mothers, should focus on mitigating both short- and long-term exposure to pollution through careful selection of cooking materials, reducing indoor pollution, and ensuring proper nutrition, vaccination, and healthcare. These measures are essential for protecting children's immune systems, reducing risks, and lowering healthcare costs. Currently, both public and private entities are engaged in campaigns and initiatives, as

evidenced by the Ministry of Public Health's efforts in managing smog (Ministry of Public Health, 2019).

Despite these endeavors, it is acknowledged that these issues persist. Prevention of respiratory infections in children necessitates protection both indoors and outdoors. This entails fostering an understanding of the issues, raising awareness about prevention methods, and acknowledging the potential impacts on individuals. Collaboration between the government and private sectors is imperative. Establishing clear guidelines, regulations, and stringent rules, such as those outlined in the Clean Air Act, is essential to mitigating these challenges and promoting sustainable health across all age groups.

5.3 Recommendation

The researchers have provided the following recommendations based on the findings:

5.3.1 Recommendations for Utilizing the Research Results

This research demonstrates the impact of air pollution on the signs and symptoms of Acute Respiratory Infection (ARI) in children. Consequently, it could serve as a guideline for air pollution management planning and immediate control strategies aimed at addressing ARI in children. Additionally, it may be integrated into the plans of public and private agencies focused on reducing smoke pollution, such as those outlined in the Clean Air Act. The data collected in this study can also be utilized to monitor ARI symptoms among marginalized communities, facilitating timely treatment and reducing the risk of acute respiratory infections and their spread.

5.3.2 Recommendations for Future Research

Further investigation of this research in broader geographical areas or at different border regions can enhance efforts to promote child health and manage ARI-related health issues. Additionally, future studies could explore medical, alternative medicine, or herbal approaches to addressing ARI in children. Collaboration with

current medical professionals to improve disease diagnosis and gathering additional information to develop prevention and treatment guidelines would also be beneficial.

5.4 Limitations of this Study

Response Bias: Participants may provide inaccurate or biased responses due to social desirability bias, where they may feel compelled to respond in a way they believe is socially acceptable rather than truthful.

Memory Recall: Participants may need help accurately recalling past events or experiences, leading to inaccurate responses.

REFERENCES

REFERENCES

2022 Global SDG Indicator Platform. (2022). *3.9.1 Mortality rate attributed to ambient air pollution*. https://sdg.tracking-progress.org/indicator/3-9-1-mortality-rate-attributed-to-ambient-air-pollution/

Air Quality and Noise Management Bureau Pollution Control Department. (2019a). *2019 Air pollution (North) situation report*. http://air4thai.pcd.go.th/webV2/download_report.php?file=northhaze_2019

Air Quality and Noise Management Bureau Pollution Control Department. (2019b). *Air pollution situation report, monthly data for the Chiang Rai Station-Mae Sai District Health Office, Mae Sai District (73T) for 2019.* http://air4thai.pcd.go.th/webV2/download_report.php?file=73T_2019

Air Quality and Noise Management Bureau Pollution Control Department. (2020a). *Air pollution situation report, monthly data for the Chiang Rai Station-Mae Sai District Health Office, Mae Sai District (73T) for 2020.* http://air4thai.pcd.go.th/webV2/download_report.php?file=73T_2020

Air Quality and Noise Management Bureau Pollution Control Department. (2020b). *2020 Air pollution (North) Situation report.* http://air4thai.pcd.go.th/webV2/download_report.php?file=northhaze_2020

Air Quality and Noise Management Bureau Pollution Control Department. (2021a). *2021 Air pollution (North) situation report.* http://air4thai.pcd.go.th/webV2/download_report.php?file=northhaze_2021

Air Quality and Noise Management Bureau Pollution Control Department. (2021b). *Air pollution situation report, monthly data for the Chiang Rai Station-Mae Sai District Health Office, Mae Sai District (73T) for 2021.* http://air4thai.pcd.go.th/webV2/download_report.php?file=73T_2021

Alamneh, Y. M., & Adane, F. (2020). Magnitude and predictors of pneumonia among under-five children in Ethiopia: A systematic review and meta-analysis. *Journal of Environmental and Public Health, 2020*, 1606783. https://doi.org/10.1155/2020/1606783

Angsuchoti, S., Wijitwanna, S., & Pinyopanuwat, R. (2014). *Statistical analysis for research in the social science and behavioural science: Using technique LISREL*. Chareondee Mankong Printing.

Arttanuchit, S., & Jeharsae, R. (2019). Folk health care practice: A case study of Lahu Ethicity in Chiangrai Province. *Academic Services Journal, 30*(2), 155-164.

Association of Respiratory Syndrome and Critical Pediatrics in Children The Royal College of Pediatricians of Thailand. (2019). *PM2.5 pollution to child and infant health.* The Royal College of Pediatricians of Thailand & Pediatric Society of Thailand.

Beletew, B., Bimerew, M., Mengesha, A., Wudu, M., & Azmeraw, M. (2020). Prevalence of pneumonia and its associated factors among under-five children in East Africa: A systematic review and meta-analysis. *BMC Pediatrics, 20*(1). https://doi.org/10.1186/s12887-020-02083-z

Crain, E. F., Walter, M., O'Connor, G. T., Mitchell, H., Gruchalla, R. S., Kattan, M., . . . Stout, J. W. (2002). Home and allergic characteristics of children with asthma in seven U.S. urban communities and design of an environmental intervention: The Inner-City Asthma Study. *Environmental Health Perspectives, 110*(9), 939–945. https://doi.org/10.1289/ehp.02110939

Croft, D. P., Zhang, W., Lin, S., Thurston, S. W., Hopke, P.K., Masiol, M., . . . Rich, D. Q. (2019). The association between respiratory infection and air pollution in the setting of air quality policy and economic change. *Annals of the American Thoracic Society, 16*(3), 321-330.

Fathmawati, F., Rauf, S., & Indraswari, B. W. (2021). Factors related with the incidence of acute respiratory infections in toddlers in Sleman, Yogyakarta, Indonesia: Evidence from the Sleman Health and Demographic Surveillance System. *PLoS ONE, 16*(9 September). https://doi.org/10.1371/journal.pone.0257881

Gothankar, J., Doke, P., Dhumale, G., Pore, P., Lalwani, S., Quraishi, S., . . . Malshe, N. (2018). Reported incidence and risk factors of childhood pneumonia in India: A community-based cross-sectional study. *BMC Public Health, 18*(1), 1111. https://doi.org/10.1186/s12889-018-5996-2

Greenpeace Thailand. (n.d.). *Differential air quality measuring standard*. Greenpeace. Retrieved April 4, 2019, from https://www.greenpeace.org/thailand/explore/protect/cleanair/air-standard/

Hassen, S., Getachew, M., Eneyew, B., Keleb, A., Ademas, A., Berihun, G., . . . Sisay, T. (2020). Determinants of acute respiratory infection (ARI) among under-five children in rural areas of Legambo District, South Wollo Zone, Ethiopia: A matched case–control study *International Journal of Infectious Diseases, 19*, 688-695.

Health Data Center. (2019a). *Respiratory system disease rate, age group, 1st health district, Chiang Rai Province*. Medical and Health Information Warehouse System, Ministry of Public Health.

Health Data Center. (2019b). *Respiratory system disease rate, agegroup, 1st health district, Chiang Rai Province, Mae Sai District, Wiang Phang Kham Sub-district*. Medical and Health Information Warehouse System, Ministry of Public Health.

Health Data Center. (2020a). *Respiratory system disease rate, age group, 1st health district, Chiang Rai Province*. Medical and Health Information Warehouse System, Ministry of Public Health.

Health Data Center. (2020b). *Respiratory system disease rate, age group, 1st health district, Chiang Rai Province, Mae Sai District, Wiang Phang Kham Sub-district*. Medical and Health Information Warehouse System, Ministry of Public Health.

Health Data Center. (2021a). *Respiratory system disease rate, age group, 1st health district, Chiang Rai Province, Mae Sai District, Wiang Phang Kham Sub-district*. Medical and Health Information Warehouse System, Ministry of Public Health.

Health Data Center. (2021b). *Respiratory system disease rate, age group, 1st health district, Chiang Rai Province*. Medical and Health Information Warehouse System, Ministry of Public Health.

HR-Guide. (2021). *Chapter 3: Understanding test quality-concepts of reliability and validity.* https://hr-guide.com/Testing_and_Assessment/Reliability_and_Validity.htm

International Federation of Red Cross and Red Crescent Societies. (n.d.). *Introduction to gender, diversity and SGBV for community resilience* [PowerPoint]. https://www.rcrc-resilience-southeastasia.org/wp-content/uploads/2016/01/Day-2_th-session-1-Introduction-GD_Thai.pdf

Jinathum, T., Koomnet, K., & Kanthawee, P. (2018). A study of health behaviors and Diabetes mellitus (DM) protection among Karen Ethnic groups in Doi Luang district, Chiang Rai. *Chiangrai Medical Journal, 10*(1), 179-192.

Keleb, A., Sisay, T., Alemu, K., Ademas, A., Lingerew, M., Kloos, H., . . . Adane, M. (2020). Pneumonia remains a leading public health problem among under-five children in peri-urban areas of north-eastern Ethiopia. *PloS one, 15*(9). https://doi.org/10.1371/journal.pone.0235818

Kids Health Information. (2020). *Cough.* https://www.rch.org.au/kidsinfo/fact_sheets/Cough/

Liu, J., Mauzerall, D. L., Chen, Q., Zhang, Q., Song, Y., Peng, W., . . . Zhu, T. (2016). Air pollutant emissions from Chinese households: A major and underappreciated ambient pollution source. *Proceedings of the National Academy of Sciences, 113*(28), 7756-7761. https://doi.org/10.1073/pnas.1604537113

Manotham, M. (2019). Healthcare knowledge and practice of Akha ethnic group: Case study at a Mae-mon Village, Tambon Huay-chom-poo, Amphur Muang, Chiang Rai. *Journal of Public Health, Burpa University*, 69-80.

Merera, A. M. (2021). Determinants of acute respiratory infection among under-five children in rural Ethiopia. *BMC Infectious Diseases, 21*(1), 1-12.

Ministry of Public Health. (2019). *Medical and public health operations manual for fine dust up to 2.5 microns (PM 2.5) year 2020*. Ministry of Public Health.

National Cancer Institute. (n.d.). *Proactive cancer newsletter: Silent catastrophe inside the building (Indoor air pollution).* National Cancer Institute. Retrieved September 25, 2010, from https://www.nci.go.th/th/Knowledge/download/4.pdf

Office of the Permanent Secretary. (2018). *Traditional General Medical Textbook* (Vol. 2). Foundation for the Promotion of Traditional Thai Medicine Restoration.

Parasin, N., Amnuaylojaroen, T., & Saokaew, S. (2021). Effect of Air Pollution on Obesity in Children: A Systematic Review and Meta-Analysis. *Children, 8*(5), 327.

Promsorn, T. (2012). *Self-care behaviors of elderly tribes. (Haw Chinese, Lahu people, Taiyai) in Nhong bua Sub district Municipality, Chaiprakarn District, Chiangmai Province* [Paper presentation]. The 9th National Academic Conference, Kasetsart University Kamphaeng Saen Campus.

Royal Project Foundation. (2021). *Hill tribe with healthcare.* https://www.royalprojectthailand.com/node/1748

Savitha, A. K., & Gopalakrishnan, S. (2018). Determinants of acute respiratory infections among under five children in a rural area of Tamil Nadu, India. *Journal of Family Medicine and Primary Care*, *7*(6), 1268.

Simoes, E. A., Cherian, T., Chow, J., Shahid-Salles, S. A., Laxminarayan, R., & John, T. J. (Eds.). (2006). *Acute respiratory infections in children.* Disease Control Priorities in Developing Countries.

Sukmag, P. (2018). *Principles of Thought: Health, health determinants, health-enhancing* [Paper presentation]. The Monitor Network Development Workshop evaluated health enhancement work in the Northern Territory, Kamphaeng-Phet province.

Sultana, M., Sarker, A. R., Sheikh, N., Akram, R., Ali, N., Mahumud, R. A., . . . Alam, N. H. (2019). Prevalence, determinants and health care-seeking behavior of childhood acute respiratory tract infections in Bangladesh. *PloS one*, *14*(1). https://doi.org/10.1371/journal.pone.0210433

Tazinya, A. A., Halle-Ekane, G. E., Mbuagbaw, L. T., Abanda, M., Atashili, J., & Obama, M. T. (2018). Risk factors for acute respiratory infections in children under five years attending the Bamenda Regional Hospital in Cameroon. *BMC Pulmonary Medicine*, *18*(1). https://doi.org/10.1186/s12890-018-0579-7

Teeratakulpisarn, J., Uppala, R., Thepsuthammarat, K., & Sutra, S. (2012). Burden of acute lower respiratory infection in children in Thailand in 2010: Have we achieved the national target in under-five morbidity and mortality. *J Med Assoc Thai*, *95*(7), 87-96.

The Royal College of Pediatricians of Thailand & Pediatrics Society of Thailand. (2019). *Care guidelines for acute infectious diseases of the respiratory system in children 2019*. The Thai Society of Pediatric Respiratory and Critical Care Medicine. https://drive.google.com/file/d/1nn75ETIG9JVRfKO_G2wlcT6sNq_vfjoM/view?usp=sharing

The Royal College of Pediatricians of Thailand & Pediatrics Society of Thailand. (2019). *Care guidelines for acute infectious diseases of the respiratory system in children 2019*. The Thai Society of Pediatric Respiratory and Critical Care Medicine. https://drive.google.com/file/d/1nn75ETIG9JVRfKO_G2wlcT6sNq_vfjoM/view?usp=sharing

The Royal College of Pediatricians of Thailand & Pediatrics Society of Thailand (n.d.). *Acute infectious disease of the respiratory system in children.* Retrieved March 28, 2022, from http://www.thaipediatrics.org/attchfile/CPG1.pdf

Thongporn, P. (2020). A study on the effectiveness of red onion gel in treating nasal congestion cold in young children *Jornal of Thai Traditional & Alternative Medicine*, *18*(2), 27.

Toniti, N. (2018). *Karen tribe health management*. Chulalongkorn Thai-Tai Heritage Forum: Healing and Herbal Medicine.

Wiangphangkham Subdistrict Municipality. (2021). *General information of Wiangpangkam Subdistrict Municipality*. http://www.wpkms.com/person/01.htm

Wiangpangkam Municipal Youth Center. (2021). *General information of Wiangpangkam Subdistrict Municipality. Wiang Phang Kham Subdistrict Municipality*. http://www.wpkms.com/innerform/Satisfy/04.pdf

Wichaidit, W., Kaewkungwal, J., Sirivichayakul, C., Taechaboonsermsak, P., & Suvithayasiri, V. (2011). Maternal and child health in a marginalized community along the Thai-Myanmar border. *Southeast Asian Journal of Tropical Medicine and Public Health*, *42*(1), 152.

Windi, R., Efendi, F., Qona'ah, A., Adnani, Q. E. S., Ramadhan, K., & Almutairi, W. M. (2021). Determinants of acute respiratory infection among children under-five years in Indonesia. *Journal of Pediatric Nursing, 60,* e54–e59. https://doi.org/10.1016/j.pedn.2021.03.010

World Health Organization (WHO). (2018a). *Air pollution and child health: prescribing clean air: summary (No. WHO/CED/PHE/18.01).* https://apps.who.int/iris/bitstream/handle/10665/275545/WHO-CED-PHE-18.01-eng.pdf

World Health Organization (WHO). (2018b). *More than 90% of the world's children breathe toxic air every day.* https://www.who.int/news/item/29-10-2018-more-than-90-of-the-worlds-children-breathe-toxic-air-every-day

World Health Organization (WHO). (2018c). *WHO housing and health guidelines.* https://www.who.int/publications/i/item/9789241550376

World Health Organization (WHO). (2024). *Children's environmental health.* https://www.who.int/health-topics/children-environmental-health#tab=tab_2

World Health Organization (WHO). (n.d.). *Indicator 3.9.1: Mortality rate attributed to household and ambient air pollution (per100- 000 population, age-standardized)*. Retrieved August 26, 2022, from https://www.who.int/data/gho/data/indicators/indicatordetails/GHO/ambient-and-household-air-pollution-attributable-death-rate-(per-100-000-population-age-standardized)

World Health Organization South-East Asia. (2020). *Children's Health and Air Pollution*. https://www.who.int/docs/default-source/searo/wsh-ochsearo/children's-health-and-airpollution.pdf?sfvrsn=36f69726_2&fbclid=IwAR3l4sMxjnAwiCOOAh9L5XFQX2grJY4Yjx3nJdpBD0b3Jfd5TEQLdwx1H0

Zhang, Y., Guo, Z., Zhang, W., Li, Q., Zhao, Y., Wang, Z., . . . Luo, Z. (2023). Effect of acute PM 2.5 exposure on lung function in children: A systematic review and meta-analysis. *J Asthma Allergy*, 16, 529-540 https://doi.org/10.2147/JAA.S405929

Zhou, X., Guo, M., Li, Z., Yu, X., Huang, G., Li, Z., . . . Liu, L. (2023). Associations between air pollutant and pneumonia and asthma requiring hospitalization among children aged under 5 years in Ningbo, 2015-2017. *Frontiers in Public Health, 10*, 1017105. https://doi.org/10.3389/fpubh.2022.1017105

APPENDICES

APPENDIX A

QUESTIONNAIRES FORM

Acute respiratory infection in children (ARIC) with PM 2.5 Questionnaire

Volunteer No. _____Village _____Interviewer name_____

Date of interview ____ / ____ / _____ Starting time _____Ending time _____

Status of volunteer ◯ mother ◯ care giver

Please circle the correct answer and indicate the number in the blank space.

Part 1 : Personal characteristics

No.	Question	Answer
1.1	Age of child	___year _____months
1.2	Sex of child	1. male 2. female
1.3	Age of mother/ care giver	_____years
1.4	Education of mother/ care giver	1. Unable to read & write 2. Able to read & write 3. Primary school or above 4. Secondary school or above 5. Bachelor's degree or above
1.5	Number of family members	_____ people
1.6	Vitamin A Supplementation	1 Yes 0 No
1.7	Zinc Supplementation	1 Yes 0 No
1.8	Pneumococcal Conjugate Vaccine (PCV)	1 Yes 0 No
1.9	Covid-19 Vaccine	1 Yes 0 No
1.10	Tuberculosis Conjugate Vaccine (BGC)	1 Yes 0 No

Part 1 : Personal characteristics

No.	Question	Answer
1.11	Status of vaccination (Ref: child's vaccination recommendation from mother and baby book) **1) Newborn** - HepB0 - BCG (before discharge or within 7 days after birth) **2) 2 months** - DTP-HepB1, OPV1 **3) 4 months** - DTP-HepB2, OPV2 **4) 6 months** - DTP-HepB3, OPV3 **5) 9 months** - MMR1 **6) 12 months (1 year)** - JE1 **7) 18 months** - DTP4, OPV4 **8) 30 months** - MMR2, JE2 **9) 9 months (4 years)** - DTP5, OPV5 **Abbreviations (Number after the letter is the order of vaccine):** - HepB: Hepatitis B vaccine - BCG: Tuberculosis (TB) disease vaccine - DTP: Diphtheria, Pertussis, Tetanus - OPV: Polio - MMR: Measles – Mumps – Rubella vaccine - JE: Japanese encephalitis vaccine	1 Fully vaccine 2 Incomplete (Partial vaccinated, unvaccinated)

Part 1 : Personal characteristics

No.	Question	Answer
1.12	History of ARI in child	1 Yes 0 No
1.13	History of congenital heart disease in child	1 Yes 0 No
1.14	History of HIV in child	1 Yes 0 No
1.15	History of TB in child	1 Yes 0 No
1.16	History of ARI in family	1 Yes 0 No
1.17	Acute malnutrition using the mid-upper arm circumference (MUAC) measurement *** It is measured by a researcher, health officer or data collector by using a tape measure	_____ cm

Part 2 Source of PM 2.5 and Environment

No.	Question	Answer
2.1	What source of energy for food cooking?	1. biomass fuels (wood, dung cakes, charcoal, urban residues) 2. kerosene 3. clean fuel (liquefied petroleum gas, electricity)
2.2	Are there cigarette smokers? How many minutes at a time?	1 Yes 0 No Smoking_____min/time
2.3	Do you burn trash outside? How many minutes at a time?	1 Yes 0 No Smoking_____ min/time
2.4	Do you use products that are cleaning spray, deodorizing spray in the house? How many minutes at a time?	1 Yes 0 No Use_____ min/times
2.5	Does the kitchen have a window?	1 Yes 0 No
2.6	Type of house	1. Wood 2. Cement 3. Wood and Cement
2.7	Is the house characteristic divided in proportion, such as whether the kitchen, bathroom, and bedroom are separated?	1 Yes 0 No

Part 3 Exposure PM 2.5

No.	Question	Answer
3.1	While cooking, where did you put the child?	1. Outside the cooking area (outside the kitchen) 2. Hold it. / It's behind mom. 3. Inside the kitchen 4. Outside the house/Open space
3.2	How long does the child stay close to you while you are cooking?	_____ min/times
3.3	Where is the child while someone smokes in the house?	1. Outside the smoking area 2. Stay close cigarette smoker 3. Outside the house/ Open space 4. Not smoking
3.4	How long has the child been around someone who smokes?	_____ min/times
3.5	During burning trash, where was the child?	1. Outside the burning area (Insidehouse) 2. Stay close burning area 3. No burning trash
3.6	How long does the child stay close to burning area?	_____ min/times
3.7	Where is the child when you use a spray cleaner or deodorant in the house?	1. Outside the spray area 2. Stay close spray area 3. Outside the house/ Open space 4. Not used
3.8	How long does the child stay close to the area that you use a spray cleaner or deodorant in the house?	_____ min/times
3.9	How long does the child spending time outside of the house?/day (e.g., activities, jogging, etc.)	_____ min/times
3.10	How long does the child spending time inside of the house?/day (e.g. playing with toys, watching TV, sleeping, etc.)	_____ min/times

Part 4 Prevention and care of child

No.	Question	Answer
4.1	Does the child use mask when going outside?	1 Yes 0 No
4.2	Mask type?	1. Medical Mask 2. Fabric Mask 3. N95 Mask 4. Other
4.3	How many masks that the child used/day?	_____piece(s)/day
4.4	How many times that the child wash his/her hands after doing the activity outside/day?	1. Always (every times) 2. Sometimes (1-2 times) 3. Never
4.5	Sanitation facility	1. In house toilet with adequate sewage disposal 2. In house toilet with not adequate sewage disposal 3. Public/ community toilet with adequate sewage disposal 4. Public/ community toilet with not adequate sewage disposal.

Part 5 Symptoms and signs of respiratory infections in children

No.	Question	Answer
5.1. Are the following sign and symptoms of acute respiratory infections in children? Within the last two months, Date interviews_____. (Starting October 2022 B.E.)		
No.	**Question**	**Answer**
5.1.1	cough (with or without fever)	1 Yes 0 No
5.1.2	Breathe fast / Breathe short	1 Yes 0 No
5.1.3	Difficulty in Breathing	1 Yes 0 No
5.1.4	Wheezing	1 Yes 0 No
5.1.5	sore throat	1 Yes 0 No

Part 5 Symptoms and signs of respiratory infections in children

5.2. Are the following sign and symptoms of acute respiratory infections in children? Within the last two months, Date interviews_____. (Starting December 2022 B.E.)		
No.	**Question**	**Answer**
5.2.1	Cough (with or without fever)	1 Yes 0 No
5.2.2	Rapid breathing / short of breath	1 Yes 0 No
5.2.3	Breathe difficul	1 Yes 0 No
5.2.4	Wheezing	1 Yes 0 No
5.2.5	Sore throat	1 Yes 0 No
5.3. Are the following sign and symptoms of acute respiratory infections in children? Within the last two months, Date interviews_____. (Starting April 2023 B.E.)		
No.	**Question**	**Answer**
5.3.1	Cough (with or without fever)	1 Yes 0 No
5.3.2	Rapid breathing / short of breath	1 Yes 0 No
5.3.3	Breathe difficul	1 Yes 0 No
5.3.4	Wheezing	1 Yes 0 No
5.3.5	Sore throat	1 Yes 0 No

APPENDIX B

THE ITEM OBJECTIVE CONGRUENCE (IOC) INDEX FOR ACUTE RESPIRATORY INFECTIONS (ARIC) WITH PM 2.5 QUESTIONNAIRE

Directions: Please check (/) the level of Item-Objective Congruence (IOC) for each item below. Your responses will be kept confidential.

+1 - if the item clearly matches objectives or ensures that the following measures meet the stated objectives. 0 - if the item is unclear or unsure whether the measures meet the objectives or not.

-1 - if the item doesn't clearly match objectives or ensure that the measure doesn't meet the stated objectives.

Research title: Prevalence of sign and symptom related to acute respiratory infections and its association with air pollution among under-five children in the marginalized community of Mae Sai district, Chiang rai province.

Objectives:

1. The study will be conducted to determine the prevalence of acute respiratory infections and symptoms among children under five years of age in the marginalized community, Mae Sai District, Chiang Rai Province.

2. The study will be conducted on the relationship between exposure to air pollution and the occurrence of acute respiratory infections among children under five years of age in the marginalized community, Mae Sai District, Chiang Rai Province.

Thank you for giving your valuable time to complete the IOC

Miss Kettasaya Suwannate
Student of Master of Public Health degree
(Border health management)

Acute respiratory infection in children (ARIC) with PM 2.5 Questionnaire

Volunteer No. _____Village _____Interviewer name_____

Date of interview ____ / ____ / _____ Starting time _____ Ending time _____

Status of volunteer ◯ mother ◯ care giver

Please circle the correct answer and indicate the number in the blank space.

Part 1 : Personal characteristics

No.	Question	Answer	-1	0	+1	Note
1.1	Age of child	____year _____months				
1.2	Sex of child	1. male 2. female				
1.3	Age of mother/ care giver	_____years				
1.4	Education of mother/ care giver	1. Unable to read & write 2. Able to read & write 3. Primary school or above 4. Secondary school or above 5. Bachelor's degree or above				
1.5	Number of family members	_____ people				
Nutritional status and medical condition						
1.6	Vitamin A Supplementation	1 Yes 0 No				
1.7	Zinc Supplementation	1 Yes 0 No				
1.8	Pneumococcal Conjugate Vaccine (PCV)	1 Yes 0 No				
1.9	Covid-19 Vaccine	1 Yes 0 No				
1.10	Tuberculosis Conjugate Vaccine (BGC)	1 Yes 0 No				

Part 1 : Personal characteristics

No.	Question	Answer	-1	0	+1	Note
1.11	Status of vaccination (Ref: child's vaccination recommendation from mother and baby book) **1) Newborn** - HepB0 - BCG (before discharge or within 7 days after birth) **2) 2 months** - DTP-HepB1, OPV1 **3) 4 months** - DTP-HepB2, OPV2 **4) 6 months** - DTP-HepB3, OPV3 **5) 9 months** - MMR1 **6) 12 months (1 year)** - JE1 **7) 18 months** - DTP4, OPV4 **8) 30 months** - MMR2, JE2 **9) 9 months (4 years)** - DTP5, OPV5	1 Fully vaccine 2 Incomplete (Partial vaccinated, unvaccinated)				

Part 1 : Personal characteristics

No.	Question	Answer	-1	0	+1	Note
	Abbreviations (Number after the letter is the order of vaccine): - HepB: Hepatitis B vaccine - BCG: Tuberculosis (TB) disease vaccine - DTP: Diphtheria, Pertussis, Tetanus - OPV: Polio - MMR: Measles – Mumps – Rubella vaccine - JE: Japanese encephalitis vaccine					
1.12	History of ARI in child	1 Yes 0 No				
1.13	History of congenital heart disease in child	1 Yes 0 No				
1.14	History of HIV in child	1 Yes 0 No				
1.15	History of TB in child	1 Yes 0 No				
1.16	History of ARI in family	1 Yes 0 No				
1.17	Acute malnutrition using the mid-upper arm circumference (MUAC) measurement	_____ cm				

Part 1 : Personal characteristics

No.	Question	Answer	-1	0	+1	Note
	*** It is measured by a researcher, health officer or data collector by using a tape measure	_____ cm				

Part 2 Source of PM 2.5 and Environment

No.	Question	Answer	-1	0	+1	Note
2.1	What source of energy for food cooking?	1. biomass fuels (wood, dung cakes, charcoal, urban residues) 2. kerosene 3. clean fuel (liquefied petroleum gas, electricity)				
2.2	Are there cigarette smokers? How many minutes at a time?	1 Yes 0 No Smoking_____min/time				
2.3	Do you burn trash outside? How many minutes at a time?	1 Yes 0 No Smoking_____ min/time				
2.4	Do you use products that are cleaning spray, deodorizing spray in the house? How many minutes at a time?	1 Yes 0 No Use_____ min/times				
2.5	Does the kitchen have a window?	1 Yes 0 No				

Part 2 Source of PM 2.5 and Environment

No.	Question	Answer	-1	0	+1	Note
2.6	Type of house	1. Wood 2. Cement 3. Wood and Cement				
2.7	Is the house characteristic divided in proportion, such as whether the kitchen, bathroom, and bedroom are separated?	1 Yes 0 No				

Part 3 Exposure PM 2.5

No.	Question	Answer	-1	0	+1	Note
3.1	While cooking, where did you put the child?	1. Outside the cooking area (outside the kitchen) 2. Hold it. / It's behind mom. 3. Inside the kitchen 4. Outside the house/Open space				
3.2	How long does the child stay close to you while you are cooking?	_____ min/times				
3.3	Where is the child while someone smokes in the house?	1. Outside the smoking area 2. Stay close cigarette smoker 3. Outside the house/ Open space 4. Not smoking				

Part 3 Exposure PM 2.5

No.	Question	Answer	-1	0	+1	Note
3.4	How long has the child been around someone who smokes?	_____ min/times				
3.5	During burning trash, where was the child?	1. Outside the burning area (Insidehouse) 2. Stay close burning area 3. No burning trash				
3.6	How long does the child stay close to burning area?	_____ min/times				
3.7	Where is the child when you use a spray cleaner or deodorant in the house?	1. Outside the spray area 2. Stay close spray area 3. Outside the house/ Open space 4. Not used				
3.8	How long does the child stay close to the area that you use a spray cleaner or deodorant in the house?	_____ min/times			/	
3.9	How long does the child spending time outside of the house?/day (e.g., activities, jogging, etc.)	_____ min/times			/	

Part 3 Exposure PM 2.5

No.	Question	Answer	-1	0	+1	Note
3.10	How long does the child spending time inside of the house?/day (e.g. playing with toys, watching TV, sleeping, etc.)	_____ min/times			/	

Part 4 Prevention and care of child

No.	Question	Answer	-1	0	+1	Note
4.1	Does the child use mask when going outside?	1 Yes 0 No				
4.2	Mask type?	1. Medical Mask 2. Fabric Mask 3. N95 Mask 4. Other				
4.3	How many masks that the child used/day?	_____piece(s)/day				
4.4	How many times that the child wash his/her hands after doing the activity outside/day?	1. Always (every times) 2. Sometimes (1-2 times) 3. Never				
4.5	Sanitation facility	1. In house toilet with adequate sewage disposal 2. In house toilet with not adequate sewage disposal 3. Public/ community toilet with adequate sewage disposal				

Part 4 Prevention and care of child

No.	Question	Answer	-1	0	+1	Note
		4. Public/ community toilet with not adequate sewage disposal.				

Part 5 Symptoms and signs of respiratory infections in children

No.	Question	Answer	-1	0	+1	Note
5.1 Symptoms and signs of respiratory infections in children within a 2 month period.						
5.1.1	cough (with or without fever)	1 Yes 0 No				
5.1.2	Breathe fast / Breathe short	1 Yes 0 No				
5.1.3	Difficulty in Breathing	1 Yes 0 No				
5.1.4	Wheezing	1 Yes 0 No				
5.1.5	sore throat	1 Yes 0 No				
5.2 Symptoms and signs of respiratory infections in children during the smog situation.						
5.2.1	Cough (with or without fever)	1 Yes 0 No				
5.2.2	Rapid breathing / short of breath	1 Yes 0 No				
5.2.3	Breathe difficul	1 Yes 0 No				
5.2.4	Wheezing	1 Yes 0 No				
5.2.5	Sore throat	1 Yes 0 No				

Signature _____ **Expert informant**

( )

Summary The Item Objective Congruence (IOC) Index

No.	Question	Expert informant				IOC index
		No.1	No.2	No.3	Note	
Part 1 : Personal characteristics						
1.1	Age of child	+1	+1	+1		1
1.2	Sex of child	+1	+1	+1		1
1.3	Age of mother/ care giver	+1	+1	+1		1
1.4	Education of mother/ care giver	+1	+1	+1		1
1.5	Number of family members	+1	0	+1	offer separate men and women	0.67
1.6	Vitamin A Supplementation	+1	+1	+1		1
1.7	Zinc Supplementation	+1	+1	+1		1
1.8	Pneumococcal Conjugate Vaccine (PCV)	+1	+1	+1		1
1.9	Covid-19 Vaccine	+1	+1	+1		1
1.10	Tuberculosis Conjugate Vaccine (BGC)	+1	+1	+1		1

No.	Question	Expert informant				IOC index
		No.1	No.2	No.3	Note	
1.11	Status of vaccination (Ref: child's vaccination recommendation from mother and baby book)	+1	+1	+1		1
1.12	History of ARI in child	+1	+1	+1		1
1.13	History of congenital heart disease in child	+1	+1	+1		1
1.14	History of HIV in child	+1	+1	+1		1
1.15	History of TB in child	+1	+1	+1		1
1.16	History of ARI in family	+1	+1	+1		1
1.17	Acute malnutrition using the mid-upper arm circumference (MUAC) measurement *** It is measured by a researcher, health officer or data collector by using a tape measure	+1	+1	+1		1
Part 2 Source of PM 2.5 and Environment						
2.1	What source of energy for food cooking?	+1	+1	+1		1

No.	Question	Expert informant				IOC index
		No.1	No.2	No.3	Note	
2.2	Are there cigarette smokers? How many minutes at a time?	+1	+1	+1		1
2.3	Do you burn trash outside? How many minutes at a time?	+1	+1	+1		1
2.4	Do you use products that are cleaning spray, deodorizing spray in the house? How many minutes at a time?	+1	+1	+1		1
2.5	Does the kitchen have a window?	+1	+1	+1		1
2.6	Type of house	+1	+1	+1		1
2.7	Is the house characteristic divided in proportion, such as whether the kitchen, bathroom, and bedroom are separated?	+1	+1	+1		1
Part 3 Exposure PM 2.5						
3.1	While cooking, where did you put the child?	+1	+1	+1		1

No.	Question	Expert informant				IOC index
		No.1	No.2	No.3	Note	
3.2	How long does the child stay close to you while you are cooking?	+1	+1	+1		1
3.3	Where is the child while someone smokes in the house?	+1	+1	+1		1
3.4	How long has the child been around someone who smokes?	+1	+1	+1		1
3.5	During burning trash, where was the child?	+1	+1	+1		1
3.6	How long does the child stay close to burning area?	+1	+1	+1		1
3.7	Where is the child when you use a spray cleaner or deodorant in the house?	+1	+1	+1		1
3.8	How long does the child stay close to the area that you use a spray cleaner or deodorant in the house?	+1	+1	+1		1

No.	Question	Expert informant				IOC index
		No.1	No.2	No.3	Note	
3.9	How long does the child spending time outside of the house?/day (e.g., activities, jogging, etc.)	+1	+1	+1		1
3.10	How long does the child spending time inside of the house?/day (e.g. playing with toys, watching TV, sleeping, etc.)	+1	+1	+1		1
Part 4 Prevention and care of child						
4.1	Does the child use mask when going outside?	+1	+1	+1		1
4.2	Mask type?	+1	+1	+1		1
4.3	How many masks that the child used/day?	+1	+1	+1		1
4.4	How many times that the child wash his/her hands after doing the activity outside/day?	+1	+1	+1		1
4.5	Sanitation facility	+1	+1	+1		1

No.	Question	Expert informant				IOC index
		No.1	No.2	No.3	Note	
5.1 Symptoms and signs of respiratory infections in children within a 2 month period.						
5.1.1	cough (with or without fever)	+1	+1	+1		1
5.1.2	Breathe fast / Breathe short	+1	+1	+1		1
5.1.3	Difficulty in Breathing	+1	+1	+1		1
5.1.4	Wheezing	+1	+1	+1		1
5.1.5	sore throat	+1	+1	+1		1
5.2 Symptoms and signs of respiratory infections in children during the smog situation.						
5.2.1	Cough (with or without fever)	+1	+1	+1		1
5.2.2	Rapid breathing / short of breath	+1	+1	+1		1
5.2.3	Breathe difficul	+1	+1	+1		1
5.2.4	Wheezing	+1	+1	+1		1
5.2.5	Sore throat	+1	+1	+1		1

Note form Expert informant**:** Please add mode questions related to nutrition as this is important for children immunity.

1) What kind of milk did you feed in the first 6 months?

1 breast milk

2 Dry milk powder

3 Mixed milk

2) How many months do you breastfeed? _____ Months

3) Does a mother have tetanus toxoid (TT) injection? 1Yes 0No

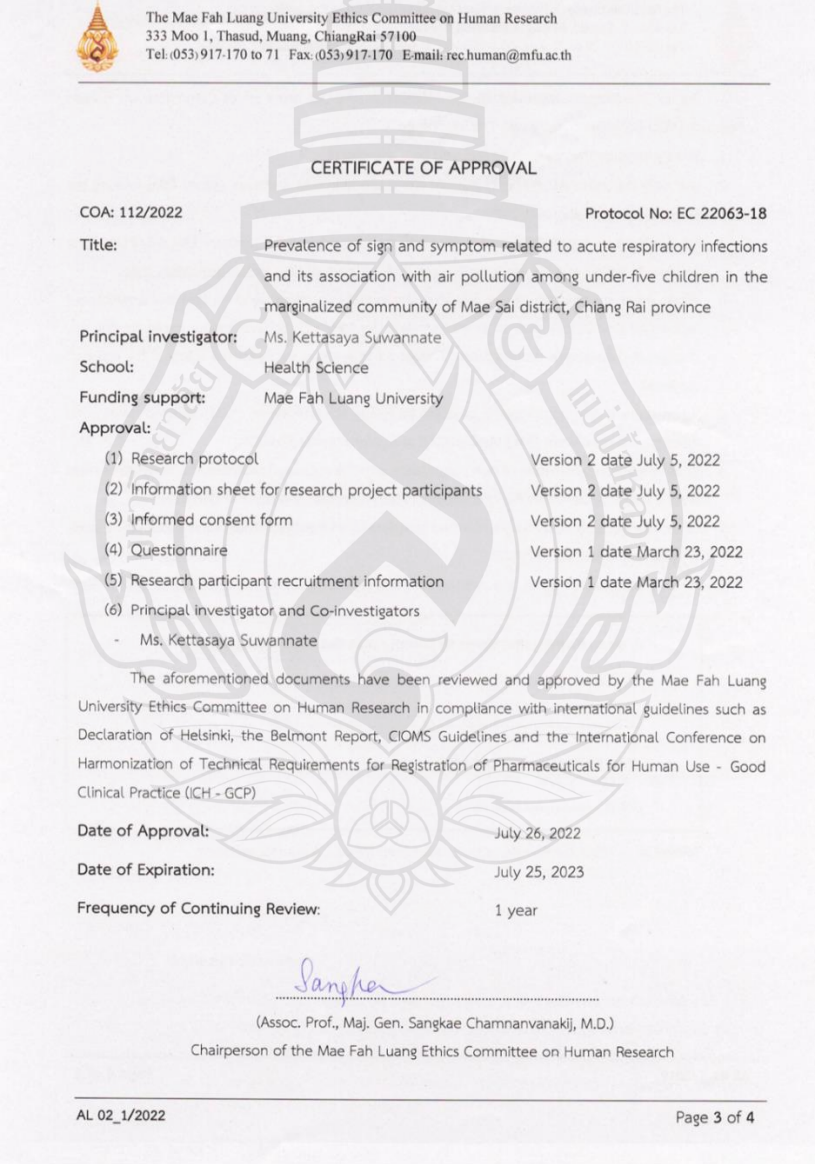
4) How many times does a mother has tetanus toxoid (TT) vaccination during pregnancy _____ times

5) Weaning of child _____ months

APPENDIX C

ETHICAL APPROVAL

Permission letter form Mae Fah Luang University Ethical Committee



The Mae Fah Luang University Ethics Committee on Human Research
333 Moo 1, Thasud, Muang, ChiangRai 57100
Tel. (053) 917-170 to 71 Fax. (053) 917-170 E-mail: rec.human@mfu.ac.th

CERTIFICATE OF APPROVAL

COA: 112/2022 Protocol No: EC 22063-18

Title: Prevalence of sign and symptom related to acute respiratory infections and its association with air pollution among under-five children in the marginalized community of Mae Sai district, Chiang Rai province

Principal investigator: Ms. Kettasaya Suwannate

School: Health Science

Funding support: Mae Fah Luang University

Approval:

(1) Research protocol	Version 2 date July 5, 2022
(2) Information sheet for research project participants	Version 2 date July 5, 2022
(3) Informed consent form	Version 2 date July 5, 2022
(4) Questionnaire	Version 1 date March 23, 2022
(5) Research participant recruitment information	Version 1 date March 23, 2022
(6) Principal investigator and Co-investigators	
- Ms. Kettasaya Suwannate	

The aforementioned documents have been reviewed and approved by the Mae Fah Luang University Ethics Committee on Human Research in compliance with international guidelines such as Declaration of Helsinki, the Belmont Report, CIOMS Guidelines and the International Conference on Harmonization of Technical Requirements for Registration of Pharmaceuticals for Human Use - Good Clinical Practice (ICH - GCP)

Date of Approval: July 26, 2022

Date of Expiration: July 25, 2023

Frequency of Continuing Review: 1 year

(Assoc. Prof., Maj. Gen. Sangkae Chamnanvanakij, M.D.)
Chairperson of the Mae Fah Luang Ethics Committee on Human Research

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Figure C1 Ethical Approval

CURRICULUM VITAE

CURRICULUM VITAE

NAME Kettasaya Suwannate

EDUCATIONAL BACKGROUND

2012 Bachelor of Applied Thai Traditional Medicine
Mae Fah Luang University
Chiang Rai, Thailand

WORK EXPERIENCE

2022-Now Applied Thai Traditional Medicine,
Integrative Medicine Clinic
Medical center hospital
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2020-2022 Applied Thai Traditional Medicine,
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