FACTORS ASSOCIATED WITH ENVIRONMENTAL HEALTH LITERACY OF PEOPLE IN MAHA SARAKHAM TOWN MUNICIPALITY, MAHA SARAKHAM PROVINCE

Rutchanun Srisupak* and Prapakorn Srisawangwong

Abstract

This study employed a survey research design aimed at examining the level of environmental health literacy and the factors associated with environmental health literacy among residents in Muang Maha Sarakham Municipality. The study focused on the prevention of health effects resulting from PM2.5 air pollution. The sample consisted of 350 individuals selected through multistage random sampling. Data were collected between November 2024 and May 2025. The data were collected using a structured questionnaire and analyzed through descriptive statistics (percentage, mean, standard deviation, maximum, and minimum) as well as inferential statistics, specifically Pearson's correlation coefficient. The findings indicated that participants demonstrated a moderate level of knowledge regarding PM2.5 (M = 6.92, SD = 0.32), a positive attitude (M = 2.92, SD = 0.23), a high level of perception (M = 2.71, SD = 0.28), and a moderate level of environmental health literacy (M = 2.36, SD = 0.17). The analysis demonstrated that age, income level, knowledge, attitude, and perception were significantly correlated with environmental health literacy ($p<0.05$). Accordingly, relevant organizations should implement continuous environmental health education and awareness programs to mitigate the risk of respiratory diseases associated with PM2.5 exposure and to improve the overall well-being of the population.

Faculty of Science and Technology, Rajabhat Maha Sarakham University, Mueang District, Maha Sarakham Province 44000

*corresponding author e-mail: rutchanun@hotmail.com

Introduction

Since 2011, Thailand has been facing significant problems with fine particulate matter with a diameter not exceeding 2.5 micrometers (PM2.5). Every year since then, there have been high levels exceeding the national air quality standards recorded in several areas across the country. The Pollution Control Department's air quality monitoring stations found that the concentrations of PM2.5 have consistently surpassed the national standard continuously from 2011 to 2022. In 2023, PM2.5 concentrations again increased in many areas. This was especially evident in Bangkok and the surrounding provinces and across the northern and northeastern regions, which were impacted by dry weather conditions, open burning activities, and heavy urban traffic congestion. At certain times, the 24-hour average PM2.5 levels were noted to be higher than the standard threshold due to these factors. In 2023, the national annual average concentration of PM2.5 ranged from approximately 20 to 35 micrograms per cubic meter. However, some areas recorded peak levels exceeding 100 micrograms per cubic meter, and the number of days with PM2.5 concentrations above the standard exceeded 80 to 100 days in certain locations. In particular, the northern region continues to suffer from transboundary haze pollution originating from neighboring countries (Pollution Control Department, 2023).

According to the 2023 Annual Environmental Quality Report published by the Office of the Natural Resources and Environmental Policy and Planning (ONEP), the overall trend of the particulate matter (PM2.5) levels showed improvement that year. Although Saraburi and several areas in the northern region recorded hotspot zones with concentrations exceeding national standards, the annual average level of PM2.5 nationwide remained within acceptable threshold. However, in 2022 during the early months of the dry season, the 24-hour average concentrations of PM2.5 in several areas continued to rise intermittently, specifically in the northern region of the country, as this area was severely affected by open burning and transboundary haze. In Bangkok and the surrounding metropolitan areas, PM2.5 levels continued to show an upward trend during periods of heavy traffic congestion and stagnant weather conditions in the winter season. Although mitigation measures like restricting open burning, limiting vehicle use, and implementing artificial rain operations were applied, reduction efforts were not

sustained. As a result, PM2.5 pollution remains a critical environmental issue that requires continuous and close monitoring (Office of Natural Resources and Environmental Policy and Planning, 2023).

In the context of this study, fine particulate matter (PM2.5) refers to airborne particles with a diameter not exceeding 2.5 micrometers which are capable of penetrating deep into the respiratory system and entering the bloodstream. Fuel combustion from vehicles, agricultural residue burning, forest fires, and various industrial processes are major sources of PM2.5. Burning of agricultural waste and high-density urban traffic are key contributors to elevated PM2.5 concentrations. Moreover, environmental conditions such as wind, humidity, and varying temperatures also play a critical role in the accumulation of particulates in the atmosphere, especially in rapidly urbanizing areas such as Bangkok and its surrounding provinces. Furthermore, the World Air Quality Report 2023–2024 by Greenpeace notes that the annual average PM2.5 in Thailand in 2023 was 23.3 µg/m³, representing an increase of approximately 28% compared to 2022, when the level was 18.1 µg/m³. In Bangkok, the annual average reached 21.7 µg/m³, which is significantly higher than the World Health Organization's recommended standard (Greenpeace, 2024).

Fine particulate matter (PM2.5) significantly affects health and is considered one of the most severe forms of air pollution because it can penetrate the respiratory system and enter the bloodstream. Such exposure can lead to health problems such as lung inflammation, abnormal cell division, and chronic illnesses including cardiovascular disease, chronic obstructive pulmonary disease (COPD), and lung cancer. Furthermore, PM2.5 can carry carcinogenic substances like polycyclic aromatic hydrocarbons (PAHs). The Ministry of Public Health reported that in the 2024 fiscal year (October 2023 to September 2024), 1.04 million patients received medical treatment for diseases related to residential PM2.5 exposure. These included 442,073 cases of dermatitis, 357,104 cases of conjunctivitis, 226,423 cases of COPD, 18,336 cases of asthma, and 4,051 cases of acute heart failure. These cases contributed to healthcare expenditures exceeding 3 billion baht. In addition, epidemiological studies in 2024 found that more than 12.3 million Thai citizens were affected by diseases caused by air pollution, with the northern region experiencing the most severe impact. These findings highlight PM2.5 as an ongoing

major public health burden in Thailand, underscoring the urgent need for systematic intervention (Ministry of Public Health, 2023a).

The issue of PM2.5 has been designated a national priority by the Thai government. To manage this issue, the government designated the Pollution Control Department as the primary agency responsible for implementing control measures targeting major sources of PM2.5, including transportation, industrial emissions, and open burning. In addition, this agency promotes the development and use of real-time satellite-based air quality monitoring systems. Furthermore, the Ministry of Public Health has established provincial emergency response centers for PM2.5, tasked with monitoring air pollution, issuing health advisories to at-risk populations, distributing protective masks, and providing public guidance on avoiding outdoor activities during high-risk periods (Ministry of Public Health, 2023a). The government is also developing and advancing the draft Clean Air Act, which aims to establish a legal framework for sustainable air pollution control. However, it should be noted that the long-term and sustainable management of PM2.5 pollution requires active public participation at all local levels. Therefore, to equip the public with knowledge and understanding of the health impacts of PM2.5, it is crucial to promote Environmental Health Literacy (EHL), enabling individuals to adopt appropriate self-protection behaviors and effectively support government measures (Thai Health Systems Research Institute, 2021).

Located in the northeastern region of Thailand, Maha Sarakham Province is one of the areas heavily affected by PM2.5 air pollution. According to air quality monitoring data from Mueang Maha Sarakham District, the area has recorded PM2.5 levels with a maximum 24-hour average concentration of 109 micrograms per cubic meter. High levels of PM2.5 in this region are mainly due to open burning of agricultural residues, which accounts for 54% of total emissions, followed by manufacturing (17%), transportation (13%), electricity generation (9%), and residential activities (7%). These pollution levels are typically observed between the months of November and March. Furthermore, haze and smoke in the northeastern region have shown an overall increasing trend over time (Pollution Control Department, 2024). Therefore, assessing the current state of environmental health literacy among residents in Maha Sarakham Municipality is essential. The findings can serve as a foundation for public health information and as

guidelines for policy development to promote and enhance environmental health literacy among local residents, enabling them to effectively implement preventive measures against health impacts.

Methodology

This study employed a survey research design.

1. Population and Sample

The study comprised 41,429 residents living in Maha Sarakham Municipality. From this population, 350 residents were selected as the study. The sample size was determined using the Krejcie and Morgan table (Krejcie & Morgan, 1970), based on a 5% margin of error and a 95% confidence level. A multistage sampling technique was employed. The population was first proportionally divided across all 30 communities within the municipality, after which convenience sampling was applied to obtain the required sample size.

2. Research Instrument

Data were collected using a researcher-developed questionnaire, which was verified by experts and tested for quality. The questionnaire consisted of five parts, as detailed below:

Part 1: Personal Information, consisting of 5 Items

Part 2: Knowledge Factors Related to PM2.5 Prevention, consisting of 10 Items

Part 3: Attitudinal Factors Related to PM2.5 Prevention, consisting of 10 Items

Part 4: Perception Factors Related to PM2.5 Prevention, consisting of 10 Items

Part 5: Environmental Health Literacy, 12 Items

Instrument Validity and Reliability: Content validity was assessed by three experts using the Index of Item-Objective Congruence (IOC) ,with values ranging from 0.5 to 1.0, ensuring that each item aligned with the research objectives. Reliability was evaluated using Cronbach's alpha coefficient ,which yielded the following values Knowledge = 0.89, Attitude = 0.71, Perception =0.92, Environmental Health Literacy = 0.85, indicating acceptable internal consistency.

Independent Variables

1. Knowledge Factors Related to PM2.5 Prevention

This refers to the extent individuals knowledge regarding PM2.5 prevention. The questionnaire consisted of 10 Yes/No items, with correct answers scored as 1 and incorrect answers scored as 0. Knowledge levels were categorized into three groups, following the criteria established by Nutbeam (2000). The following score ranges were established to classify levels of knowledge regarding PM2.5 prevention:

Level of Knowledge	Total Score
Good:	8-10 points
Moderate:	5-7 points
Poor:	0 - 4 points

2. Attitudinal Factors Related to PM2.5 Prevention

This refers to respondents' attitudes toward the prevention of PM2.5, assessed through a questionnaire comprising 10 items. Each item is rated on a three-point scale: Agree, Uncertain, and Disagree. The scoring is detailed as follows:

Scoring Criteria

Response Choice Scores for Positive Statement Scores for Negative Statements

Agree	3 points	1 point
Uncertain	2 points	2 points
Disagree	1 point	3 points

Therefore, the interpretation of attitudes toward PM2.5 prevention is based on score range classifications divided into three levels, consistent with previous studies in environmental health literacy (Muttika, 2021).

The scoring criteria are as follows:

Agree:	average score ranging from 2.34 - 3.00
Uncertain:	average score ranging from 1.67 - 2.33
Disagree:	average score ranging from 1.00 - 1.66

3. Perceived Risk Factors Related to PM2.5 Exposure

This refers to a questionnaire assessing individuals' perceptions regarding PM2.5, including perceived risk of respiratory diseases, perceived severity of PM2.5, and

perceived benefits of PM2.5 prevention. The scale consisted of three levels: High, Moderate, and Low. The scoring is assigned as follows:

Response Choice Scores for Positive Statements Scores for Negative Statements

High	3 points	1 point
Moderate	2 points	2 points
Low	1 point	3 points

Therefore, interpretation of perceived risk of respiratory diseases was based on average score ranges organized into three levels, consistent with measurement approaches used in recent PM2.5 studies (Sarawit, 2023).

The scoring criteria are as follows:

High Level of Perception: average score ranging from 2.34-3.00

Moderate Level of Perception: average score ranging from 1.67-2.33

Low Level of Perception: average score ranging from 1.00-1.66

Dependent Variable

4. Environmental Health Literacy: This section entails 12 items with responses being rated on a three-level scale: High, Moderate and Low. The scoring is assigned as follows:

Response Choice Scores for Positive Statements Scores for Negative Statements

High	3 points	1 point
Moderate	2 points	2 points
Low	1 point	3 points

Therefore, interpretation of perceived risk of respiratory disease was based on average score ranges organized into three levels consistent with measurement approaches used in recent Pm 2.5 studies (Jittima, 2024; Sumritwatcharsai & Chakhamrun, 2023).

The scoring criteria are as follows:

High-Level of Perception: average score ranging from 2.34-3.00

Moderate Level of Perception: average score ranging from 1.67-2.33

Low Level of Perception: average score ranging from 1.00-1.66

3. Data Collection

Data collection was conducted in The following steps:

3.1   Coordination with Maha Sarakham Municipality to obtain permission for data collection within Mueang Maha Sarakham District, Maha Sarakham Province.

3.2   Administration of the questionnaire to collect data from the target sample.

3.3   Compilation of data for subsequent analysis.

4. Statistical Analysis

4.1   Descriptive statistics included percentage, means, standard deviations, and minimum and maximum values.

4.2   Inferential statistics included the Pearson product-moment correlation coefficient. Statistical significance was set at **α**=0.05 (two-tailed), and significant coefficients in Table 5 are denoted with an asterisk (*) All analyses were performed using statistical software packages.

Results

1.   Research Findings on Environmental Health Literacy Among the residents in Preventing Health Impacts from Fine Particulate Matter (PM2.5) in Maha Sarakham Municipality.

1.1   Demographic characteristics of the Respondents

The demographic findings showed that most respondents (n=350) were female (189 individuals, 54.2%). The average age of participants was 51.34 years (SD= 5.75), ranging from 39 to 62 years. Regarding marital status, most participants were married (217 individuals or 62.0%). In terms of education, the majority had completed secondary education, comprising 199 individuals or 57.0 percent. As for occupational status, most respondents were engaged in agriculture (254 individuals,72.7%). One-third of respondents (120 individuals, 34.3%) reported no chronic illnesses. Monthly income data showed that the largest group earned between 5,001 and 10,000 baht per month, accounting for 165 individuals or 47.2 percent.

1.2   Knowledge related to PM2.5 Prevention

The findings indicate that the sample group had a moderate level of knowledge regarding PM2.5 prevention, with a mean score of 6.92 (SD=0.32), representing 81.8% ,as shown in Table 1.

Table 1 Knowledge factors related to PM2.5 Prevention.

Knowledge Regarding PM2.5 Prevention	Levels of Knowledge Regarding PM2.5 Prevention (n = 350)					
	Good (8 – 10 points)	Moderate (5 – 7 points)	Not Good (0 – 4 points)	$\bar{x}$	SD	Interpretation of Results
	Frequency (Percentage)	Frequency (Percentage)	Frequency (Percentage)			
Knowledge of PM2.5 Prevention	64 (18.28)	238 (81.86)	3 (0.86)	6.92	0.32	Moderate

Overall, the findings show that participants demonstrated moderate knowledge levels with gaps in long-term health awareness. Items with higher scores reflected strong awareness of basic prevention practices, while lower scores suggested limited understanding of long-term health risks and technical measures. These results highlight areas for future PM2.5 knowledge promotion.

1.3   Attitudes related to PM2.5 Prevention

The findings indicate that respondents' overall attitude toward PM2.5 prevention was at the "agree" level, with a mean score of 2.92 (SD = 0.23), accounting for 92.5%, as shown in Table 2.

Table 2 Frequency, Percentage, Mean, and Standard Deviation of the Sample Group's Attitudes Toward PM2.5.

Attitude Toward PM2.5 Prevention	Levels of Attitude Toward PM2.5 Prevention (n = 350)					
	Agree (2.34 – 3.00)	Uncertain (1.67 – 2.33)	Disagree (1.00 – 1.66)	$\bar{x}$	SD	Interpretation of Results
	Frequency (Percentage)	Frequency (Percentage)	Frequency (Percentage)			
Attitude Toward PM2.5 Prevention	324 (92.58)	20 (5.71)	6 (1.71)	2.92	0.23	Agree

1.4 Perceived risk factors related to PM2.5

The findings indicate that the respondent overall perceived risk related to PM2.5 was at a high level, with a mean score of 2.71 (SD = 0.28), representing 94.2%, as shown in Table 3.

Table 3 Frequency, Percentage, Mean, and Standard Deviation of the Sample Group's Perceived Risk Factors Related to PM2.5.

| Perception of Risk Related to PM2.5 | Levels of Perceived Risk Related to PM2.5 (n = 350) | | | | | |
	High (2.34 – 3.00) Frequency (Percentage)	Moderate (1.67 – 2.33) Frequency (Percentage)	Low (1.00 – 1.66) Frequency (Percentage)	$\bar{x}$	SD	Interpretation of Results
Perceived Risk of PM2.5 Exposure	324 (92.58)	17 (4.86)	10 (2.86)	2.71	0.28	High

1.5 Environmental health literacy factors

The findings indicate that respondents had a moderate level of environmental health literacy, with a mean score of 2.36 (SD = 0.17), representing 93.1%, as shown in Table 4.

Table 4 Frequency, Percentage, Mean, and Standard Deviation of the Sample Group's Environmental Health Literacy.

| Environmental Health Literacy | Levels of Environmental Health Literacy (n = 350) | | | | | |
	High (2.34 – 3.00) Frequency (Percentage)	Moderate (1.67 – 2.33) Frequency (Percentage)	Low (1.00 – 1.66) Frequency (Percentage)	$\bar{x}$	SD	Interpretation of Results
Environmental Health Literacy	12 (3.43)	326 (93.14)	12 (3.43)	2.36	0.17	Moderate

Overall, respondents demonstrated a moderate level of environmental health literacy (M=2.36, SD= 0.17), representing 93.1%, as shown in Table 4. Closer examination showed that certain items, such as awareness of available protective measures, scored higher, while other items, such as consistent adoption of preventive behaviors, scored lower. This pattern suggests that targeted literacy interventions should emphasize weaker areas.
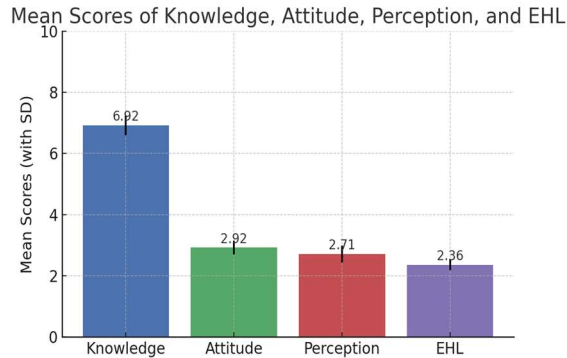
Figure 1 Mean scores and standard deviations of knowledge, attitude, perception, and environmental health literacy among residents in Maha Sarakham Municipality.

In addition to the tabulated results, Figure 1 depicts the mean and standard deviations for knowledge, attitude, perception, and environmental health literacy. The figure shows that knowledge was moderate, attitudes were positive, perceptions were high, and environmental health literacy was moderate overall. This pattern emphasizes the disparity between high perceived danger and only intermediate literacy, implying that additional interventions are required to improve consistent knowledge and practice.

2. Findings on Factors Associated with Environmental Health Literacy Among the Residents in Preventing Health Impacts from Fine Particulate Matter (PM2.5) in the Maha Sarakham Municipality

Table 5 Relationship Between Age, Income, Knowledge, Attitudinal, Perception, and Environmental Health Literacy.

Variable	R	p-value
Age and Environmental Health Literacy	0.35	<0.01*
Income and Environmental Health Literacy	0.27	0.17
Knowledge Factors and Environmental Health Literacy	0.91	<0.01*
Attitudinal Factors and Environmental Health Literacy	0.55	0.25
Perception Factors and Environmental Health Literacy	0.73	<0.01*

Remark *p<0.01 indicates statistical significance

According to Table 5, the analysis of the relationship between age, knowledge, attitudinal, perception, and environmental health literacy revealed that age ($r = 0.35$, $p <0.01^*$), knowledge ($r = 0.91$, $p <0.01^*$) and perception ($r = 0.73$, $p <0.01^*$) were significantly associated with environmental health literacy, while income ($r = 0.27$, $p = 0.17$) and attitude

(r = 0.55, p = 0.25) were not statistically significant. The Pearson correlation coefficients (r) for these variables were 0.35, 0.27, 0.91, 0.55, and 0.73, respectively, confirming the relationships identified above.

Discussions

This study found that the residents of Maha Sarakham Municipality demonstrated a moderate level of environmental health literacy regarding PM2.5 prevention. This finding aligns with Muttika (2021) who reported similar literacy levels among village health volunteers in eco-industrial contexts. Literacy levels were found to be significantly associated with knowledge, attitude, and perception, consistent with the present study's findings. Specifically, knowledge was moderate overall, indicating that while residents understand basic prevention practices, they lack deeper awareness of long-term health risks. Attitudes were generally positive, yet the presence of some uncertainty indicates a need for targeted interventions to strengthen consistent preventative behaviors. Perception of risk was high, which reflects strong concern about PM2.5 exposure and represents a motivating factor that public health campaigns can build upon. Furthermore, these results align with Sumritwatcharsai & Chakhamrun (2023) who found that variations in literacy directly influenced understanding and preventive behavior related to PM2.5, as well as with Sarawit (2023) who observed that youth understanding and access to information differed depending on individual and contextual factors.

In addition, perception of personal roles and responsibilities was significantly correlated with health literacy, aligning with the findings of Paitoon (2022). In particular, a key component of higher literacy was recognized to be one's contribution to environmental care. Cognitive and social skills were also highlighted in Supha (2023) as being crucial in shaping health knowledge among pregnant women, with midwives playing a key role in promoting behaviors that reduce PM2.5 exposure.

To address the gaps identified in knowledge, attitudes and perceptions, several strategies are recommended. Public health agencies should strengthen educational programs focusing on long-term health impacts of PM2.5 and practical protective measures (Nutbeam, 2000). Community campaigns can reduce uncertainty in attitudes and encourage routine preventative behaviors (Pansakun et al., 2024). Risk communication

strategies should leverage the already high risk perception to motivate sustained protective practices (Sumritwatcharsai & Chakhamrun, 2023).

To enhance environmental health literacy, the public should be continuously educated through diverse channels such as online platforms, schools, and local campaigns. (Imman et al., 2023). This should also be carried out alongside stakeholder collaboration and community participation across environmental health activities. Finally, a comprehensive evaluation and monitoring system should be developed to ensure that citizens acquire and retain adequate knowledge. If not, these strategies should be adjusted to meet real-world needs (Paitoon, 2022).

Conclusions

The present study concludes that residents of Maha Sarakham Municipality possess a moderate level of environmental health literacy with regard to the prevention of health impacts caused by PM2.5. Key factors influencing these literacy levels include knowledge, attitude, perception, and awareness of individual roles and responsibilities. These findings highlight the need for targeted public health strategies and their importance in not only providing information but also actively fostering community engagement and personal accountability. Instead of relying on just disseminating information to the public, effective PM2.5 prevention requires governments and citizens alike to foster a stronger sense of civic responsibility along with access to practical, everyday tools for protection. However, this study has certain limitations. The cross-sectional design restricts causal inference, reliance on self-reported data may introduce recall or social desirability bias, and the findings are specific to Maha Sarakham Municipality, limiting their generalizability to other areas.

Practical implications can be drawn from these results. Policymakers should implement continuous community-based health and education campaigns, while health educators should strengthen learning on long-term health risks and consistent preventive practices. Collaborative efforts through municipal programs, and local health centers can build on the community's high risk perception to sustain protective behaviors. Future research should design and evaluate participatory frameworks that empower communities to co-develop and maintain environmental health initiatives grounded in their own realities.

Reference

Chokchai K, Paweena K. Environmental health literacy among village health volunteers in preventing health impacts from PM2.5 in the special economic development zone, Tak Province. Journal of Disease Prevention and Control, Region 2 Phitsanulok. 2022;9(2).

Greenpeace. 2023 World Air Quality Report. March 2024. Available at: https://www.greenpeace.org /static/planet4-india-stateless/2024/03/44a856c8-2023_world_air_quality_report.pdf. Accessed October 20, 2025.

Imman K, Imman S, Ponmark J, Woragidpoonpol P. Factors associated with environmental health literacy and prevention behavior of PM2.5 for pre-school children among guardians in childcare centers in Phayao Province, Thailand. Journal of Research in Nursing-Midwifery and Health Sciences 2023;43(1):146-156.

International Agency for Research on Cancer. Cancer Today: Thailand Factsheet. Lyon, France: Global Cancer Observatory; 2024. Available at: https://gco.iarc.who.int/media/globocan/factsheets/ populations/764-thailand-fact-sheet.pdf. Accessed October 20, 2025.

Jittima R. A study of environmental health literacy for PM2.5 prevention among village health volunteers: A case study of an eco-industrial city. Journal of Health Promotion and Environmental Health 2024;47(4):75-90.

Krejcie RV, Morgan DW. Determining sample size for research activities. Educational and Psychological Measurement 1970;30(3):607-610. doi:10.1177/001316447003000308.

Ministry of Natural Resources and Environment. Thailand Environmental Quality Situation Report 2022. Bangkok: Office of Natural Resources and Environmental Policy and Planning; 2023. Available at: https://www.onep.go.th/ebook/emed/epi-report-2023.pdf. Accessed October 20, 2025.

Ministry of Public Health. Summary Report on Medical and Public Health Emergency Response to Haze and PM2.5 Issues in Thailand. Bangkok: Office of the Permanent Secretary, Ministry of Public Health; 2023a. Available at: https://www.opm.go.th/.../ฝุ่น%20PM2_5%20ปี%202567.pdf. Accessed October 20, 2025.

Ministry of Public Health. Annual Report 2023: Health Surveillance of PM2.5 Impacts [Ammual Report 2 023 :Health Impacte Surveillkance of Pm2.5]. Bangkok: Office of the Permanent Secretary, Ministry of Public Health, Thailand; 2023b. Available at: https://hia.anamai.moph.go.th/web-upload/12xb1c83353535e43f224a05e184d8fd75a/filecenter/kpi/2566/10/10_aug/3.35/kpi66_aug _3.35_01.pdf. Accessed October 20, 2025.

Muttika Y. Environmental health literacy on the prevention of health impacts from fine particulate matter (PM2.5) by village health volunteers in an eco-industrial city under Health Region 5. Journal of Health Promotion and Environmental Health 2021;44(2):83-96.

Nutbeam D. Health literacy as a public health goal: A challenge for contemporary health education and communication strategies into the 21st century. Health Promotion International 2000;15(3):259-267.doi:10.1093/heapro/15.3.259.

Office of Natural Resources and Environmental Policy and Planning. Environmental Epidemiological Report 2023. Bangkok: Ministry of Natural Resources and Environment, Thailand; 2023. Available at: https://www.onep.go.th/ebook/emed/epi-report-2023.pdf. Accessed October 20, 2025.

Paitoon D. Factors influencing health literacy among village health volunteers at Khlong Si Health Promoting Hospital, Village No. 13, Khlong Si Subdistrict, Khlong Luang District, Pathum Thani Province. Journal of Environmental Health and Community Health 2022;9(5):845-852.

Pansakun S, Srithongrung A, Namsai S. Environmental health literacy regarding fine particulate matter (PM2.5) among village health volunteers in the upper northern region of Thailand. Journal of Environmental and Public Health 2024;1–10. doi:10.1155/2024/1234567.

Pollution Control Department. Provincial Pollution Situation Report 2024 [Provincial Pollution Situation Reprot,2024]. Bangkok: Ministry of Natural Resources and Environment, Thailand; 2024. Available at: https://www.pcd.go.th/publication/36836/. Accessed October 20, 2025.

Sarawit S. Environmental health literacy and PM2.5 prevention behaviors among highland youth during open burning in Phayao Province, Thailand. Journal of Community Public Health 2023;9(1):9-20.

Sumritwatcharsai W, Chakhamrun N. Development of an environmental health literacy model for village health volunteers to prevent the health effects of PM2.5 in Samut Prakan Province. Journal of Occupational Health and Safety at Work Association of Thailand 2023;14(2):63-77.

Supha P. Promoting health knowledge among pregnant women to prevent exposure to fine particulate matter (PM2.5): The role of midwives. Thai Red Cross Nursing Journal 2023;16(2):42-53.

Thai Health Systems Research Institute. Environmental Health Literacy. Bangkok: HSRI Press; 2021.