Factors Influencing Self-Protective Behaviors From Exposure to Fine Particulate Matter Among Community-Dwelling People in Chiang Rai, Thailand

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Abstract

Background: Fine particulate matter with a diameter of 2.5 μm or less ($PM_{2.5}$) dust has emerged as a major air pollution concern in Thailand.

Objective: To investigate the factors influencing self-protective behaviors from exposure to $PM_{2.5}$ or less among people in community-dwelling in Chiang Rai province.

Methods: A community-based cross-sectional study was conducted to collect data from 216 participants in the Rong Chang subdistrict, Pa Dad district, Chiang Rai province, Thailand. Validated questionnaires were administered to gather information from March and April 2025. Data were analyzed using descriptive statistics, Pearson product-moment and Spearman rank correlation coefficients, and multiple linear regression.

Results: The results revealed that 63.40% of the participants were female, with a mean (SD) age of 54.63 (15.27) years. Additionally, 56.00% had completed primary education, and 60.10% worked as farmers. More than half of the participants (56.40%) exhibited a high level of protective behavior. Multiple linear regression analysis revealed that access to air quality and health information about $PM_{2.5}$ (B = 1.092, β = 0.590), attitude toward $PM_{2.5}$ (B = 0.272, β = 0.146), and age (B = 0.048, β = 0.110) significantly influenced self-protective behavior (adjusted R^2 = 0.468).

Conclusions: The findings highlight that the relevant organization should promote public health interventions focusing on the attitude regarding $PM_{2.5}$ and access to air quality and health information about $PM_{2.5}$ among the dwelling community. Furthermore, tailored interventions specifically targeting at age-specific populations are recommended.

Keywords: Self-protective behavior, $PM_{2.5}$, Influencing factors

Introduction

Fine particulate matter with a diameter of 2.5 μm or less ($PM_{2.5}$) dust, a serious air pollutant, is a considerable public health problem in developed and developing countries.[1] Air pollution has emerged as a critical environmental and public health issue caused by several sources, such as burning fossil fuels, rapid urbanization, industrial activities, construction, household cooking, and wildfires.[2-4] However, targeted $PM_{2.5}$ prevention and

regulatory strategies to mitigate its effects are needed. Policy interventions targeting industrial emissions, transportation, and agricultural burning have been challenged in the country.[5-7]

More than 7 million premature deaths occur annually in areas with high concentrations of $PM_{2.5}$, with over half of these deaths (62%) resulting from air pollution-related illnesses.[8] Short-term exposure to dust can cause symptoms of dust-related disorders, such as allergies, coughing, sneezing, skin rash, eye irritation, and conjunctival redness.[9] Several studies have found that exposure to $PM_{2.5}$ is directly related to health problems, especially cardiovascular and respiratory diseases, as well as cancer.[10-12] Furthermore, long-term exposure to $PM_{2.5}$ affects mental health, contributing to disorders such as anxiety, and may directly damage the brain by causing nerve damage, resulting in cognitive impairment.[13-14]

Thailand is experiencing air pollution issues, particularly in the northern region, encompassing Chiang Mai, Chiang Rai, Lampang, Lamphun, Mae Hong Son, Nan, Payao, and Phrae provinces.[3,15] In 2022, the northern region of Thailand was classified as the highest $PM_{2.5}$.[16] It is still a critical concern that the $PM_{2.5}$ concentration level frequently exceeds the World Health Organization (WHO) 24-hour guideline of 25 μg/m³,[17] and more than the national standard of the National Ambient Air Quality Standard set by Thailand, which is 37.5 μg/m³ for the 24-hour average and 15.0 μg/m³ for the annual average.[16]

Chiang Rai is a province located on the border of Thailand, Myanmar, and Laos. The context has shifted from an agriculture-based economy to an export-manufacturing one, contributing to air pollution.[3] Several studies have shown that this province is classified as a high-risk area of $PM_{2.5}$ and exceeds the standard.[3, 18] The primary contributors are the open burning of crop residues and forest fires that occur during the dry season, from January to April. Forest fires in neighboring countries, such as Myanmar and Laos, can also transport air pollutants across Thailand.[3, 18] The Rong Chang subdistrict in Pa Dad district is classified as a high-risk area. Although studies on self-protective behaviors have been conducted across various regions, few have focused on individuals living in border areas, such as the Rong Chang subdistrict, where residents face unique environmental and socioeconomic challenges. This research gap highlights the need to examine self-protective behaviors in this high-risk context, offering targeted insights for effective public health interventions.

Consequently, adopting measures to decrease the health risk associated with dust exposure is essential. Self-protective include encompass updating situational awareness and information, recognizing health risks associated with dust exposure, and implementing protective strategies, such as using certified facemasks (eg, N95 respirators), staying at home away from outdoor activities during periods of elevated pollution, maintaining vigilance, and monitoring for physiological abnormalities. Additional preventive actions include cleaning the residence to decrease dust accumulation, closing doors and windows, and activating a fan to enhance air circulation.[19-21]

However, there is scientific information regarding self-protective behavior among people in community dwellings, particularly in border areas, during the $PM_{2.5}$ exceedance. Therefore, this study aimed to determine self-protective behavior and its influencing factors among people in the Rong Chang subdistrict, Pa Dad district, Chiang Rai province. The findings of this study will inform the development of tailored public health interventions with targeted interventions in each area.

Methods

Study Design and Setting

A community-based cross-sectional study was conducted to examine self-protective behaviors among residents of Rong Chang subdistrict, Pa Dad district, Chiang Rai province, during periods when $PM_{2.5}$ levels exceeded national standards.

The study involved 216 participants from 12 villages in Rong Chang subdistrict, Pa Dad district, Chiang Rai province, where $PM_{2.5}$ levels exceeded national standards. The villages include Pong Sli, San Kong, Pong, Rong Chang Tai, Den, Don Kaew, Si Bang Wan, Thung Tha Nalai, Si Samit, Pong Si Nakorn, Thung Si Thong, and Rong Chang Nua. Data were collected between March and April 2025.

Study Sample and Sample Size Calculation

The sample size was calculated using Cochran's sample size formula.[22] Considering that the previous study was 15%,[21] with 95% as the confidence interval, the margin of error was set to 0.05%.

Therefore, the total sample size was approximately 196 participants. An additional 10% nonresponse rate was observed; therefore, the calculation indicated that a minimum of 216 participants were required to obtain accurate data.

The inclusion criteria in this study were as follows: participants aged 18 years and older, residing in the Rong Chang subdistrict for at least 1 year, without a history of brain disorders and recent signs of cognitive impairment, able to communicate in Thai, and willing to participate in the research. Exclusion criteria were participants who were absent from the data collection day.

A multistage sampling method was applied: stage 1, purposive sampling to select one subdistrict from Pa Dad district, Chiang Rai province; stage 2, proportional-to-size sampling to ensure the sample represented the population distribution in the subdistrict; and stage 3, simple random sampling to select participants from the residents' name list for data collection.

Research Instruments

Structural questionnaires were administered. It consists of 5 parts as follows:

Part 1: General characteristics of the participants, including gender, age, education level, and occupation.

Part 2: Assessment of knowledge about $PM_{2.5}$.[23] It consists of 10-item closed-ended questions with 2 possible answers, "yes" and "no". The correct answer gets "1 point" and the incorrect answer gets "0 points". The total possible score ranges from 0 to 10 points. A higher score indicates higher knowledge. The score was classified into 3 levels: low (0-5 points), moderate (6-7 points), and high (8-10 points).[24] In this study, the index of item-objective congruence (IOC) was 1, and the Kuder-Richardson was 0.78.

Part 3: Evaluate attitudes toward $PM_{2.5}$ and perceived concern regarding its health effects.[25] It consists of 5 items with a 5-point Likert scale, ranging from "1 = strongly disagree" to "5 = strongly agree". The total possible score ranges from 5 to 25 points. A higher score indicates greater concern about $PM_{2.5}$ effects. The equal with the binning method was also performed to divide the score into 3 groups, with an equal range for each group and defined as (maximum to minimum)/3. The score was classified into 3 levels: low (1.00-2.33), moderate (2.34-3.67), and high (3.68-5.00).[26] The IOC in the present study was 1, and Cronbach α was 0.83.

Part 4: Access to air quality and health information.[27] It consists of 5 items with 5-point Likert scale opinions, ranging from "1 = strongly disagree" to "5 = strongly agree". The total possible score ranges from 5 to 25 points. A higher score indicates higher access to air quality information. The equal with the binning method was also used to divide the score into 3 groups, with an equal range for each group and defined as (maximum − minimum)/3. The score was classified into 3 levels: low (1.00-2.33), moderate (2.34-3.67), and high (3.68-5.00).[26] The IOC in the present study was 1, and Cronbach α was 0.80.

Part 5: Self-protective behavior about $PM_{2.5}$.[25] It consists of 10 items with 5-point Likert scale opinions, ranging from "1 = strongly disagree" to "5 = strongly agree". The total possible score ranges from 10 to 50 points. A higher score indicates higher self-protective behavior. The equal with the binning method was also used to divide the score into 3 groups, with an equal range for each group and defined as (maximum − minimum)/3. The score was classified into 3 levels: low (1.00-2.33), moderate (2.34-3.67), and high (3.68-5.00).[26] The IOC in the present study was 1, and Cronbach α was 0.88.

Three public health experts assessed the content's validity. The IOC, which is greater than or equal to 0.5, is accepted. The pilot test was conducted among 30 participants with characteristics similar to those of the participants. Cronbach α coefficient of more than or equal to 0.7 is considered acceptable.

Statistical Analysis

The data collected were analyzed using Stata/SE, version 17.0 (StataCorp LLC). Descriptive statistics were used for all variables, including percentages, and mean (SD). Pearson product-moment correlation and Spearman rank correlation coefficients were used to assess the relationship between independent variables and self-protective behaviors. Multiple linear regression analysis using the stepwise method to identify factors influencing self-protective behavior at the significance level of $P < .05$.

Results

General Characteristics of the Participants

A total of 216 participants from 12 villages in Rong Chang subdistrict, Pa Dad district, Chiang Rai province, participated in this study. Most of the participants were female (63.40%), with a mean (SD) age of 54.63 (15.27) years (range, 18-92 years). Additionally, 56.00% had completed primary education, and 60.10% worked as farmers (Table 1).

Regarding knowledge about $PM_{2.5}$, most participants demonstrated a high level of knowledge (67.10%), moderate attitude toward $PM_{2.5}$ (61.60%), and high level of access to information about air quality and health related to $PM_{2.5}$ (58.30%) (Table 1).

The self-protective behaviors of the participants in Rong Chang subdistrict, Pa Dad district, Chiang Rai province, showed 56.40% of high level, 43.10% of moderate level, and 0.50% of low level.

Correlation Between Independent Variables and Self-Protective Behavior

This study found significant positive correlations between self-protective behavior and age (r = 0.203, P = .003), knowledge about $PM_{2.5}$ (r = 0.287, P < .001), attitude toward $PM_{2.5}$ (r = 0.276, P < .001), and access to air quality and health information about $PM_{2.5}$ (r = 0.585, P < .001) (Table 2).

Factors Influencing Self-Protective Behavior

The result of multiple linear regression analysis showed that 3 variables, including access to air quality and health information about $PM_{2.5}$ (B = 1.092, β = 0.590), attitude toward $PM_{2.5}$ (B = 0.272, β = 0.146), and age (B = 0.048, β = 0.110), were statistically significant in influencing self-protective behavior (adjusted R^2 = 0.468) (Table 3). This relationship showed in an equation as follow: self-protective behavior = 9.283 + 1.092(Access air quality and health information about $PM_{2.5}$) + 0.272(Attitude toward $PM_{2.5}$) + 0.048(Age)

Table 1. General Information of Participants	
Characteristic	**No. (%)**
Sex	
Male	79 (36.60)
Female	137 (63.40)
Age, y	31 (22.5)
< 29	18 (8.30)
30-39	11 (5.10)
40-49	37 (17.10)
50-59	58 (26.90)
> 60	92 (42.60)
Education level	
Illiterate	4 (1.90)
Primary school	121 (56.00)
Secondary school	66 (30.50)
Vocational certificate /higher vocational certificate	13 (6.00)
Bachelor's degree	12 (5.60)
Occupation	
Farmer	130 (60.10)
Self-employed/business owner	36 (16.60)
Housewife	19 (8.80)
Employee	9 (4.20)
Student	9 (4.20)
Government officer	4 (1.90)
Retired/other	9 (4.20)
Knowledge about $PM_{2.5}$	
Low	12 (5.60)
Moderate	59 (27.30)
High	145 (67.10)
Attitude toward $PM_{2.5}$	
Low	6 (2.80)
Moderate	133 (61.60)
High	77 (35.60)
Access to air quality and health information about $PM_{2.5}$	
Low	4 (1.90)
Moderate	86 (39.80)
High	126 (58.30)

Table 2. Pearson Product-Moment Correlation Coefficients Among the Factors

Factor	Self-Protective Behavior	
	Correlation	P Value
Gender (male = 0, female = 1)*	0.071	.300
Age	0.203	.003
Occupation (others = 0, farmer = 1)*	-0.069	.316
Education level (illiterate = 0, primary school = 1, secondary school = 2, vocational certificate = 3, bachelor's degree = 4)*	0.027	.692
Knowledge about $PM_{2.5}$	0.287	< .001
Attitude toward $PM_{2.5}$	0.276	< .001
Access to air quality and health information about $PM_{2.5}$	0.585	< .001

* Spearman rank correlation coefficient.

Table 3. Stepwise Multiple Linear Regression Analysis of Factors Influencing to Self-Protective Behavior

Factor	Unstandardized Coefficients		Standardized Coefficients	t	P Value
	B	SE	β		
Access to air quality and health information about $PM_{2.5}$	1.092	0.100	0.590	10.912	< .001
Attitude toward $PM_{2.5}$	0.272	0.102	0.146	2.652	.009
Age	0.048	0.022	0.110	2.158	.032
Constant	9.283	2.205	NA	4.211	< .001

Abbreviation: NA, not applicable.

Discussion

This study found that most participants demonstrated a high level of self-protective behavior (56.5%) regarding exposure to $PM_{2.5}$ among individuals in communities in Chiang Rai province. Several factors predicting self-protective behavior include access to air quality and health information about $PM_{2.5}$, attitude toward $PM_{2.5}$, and age.

Self-Protective Behavior

In this study, the self-protective behavior exposure from $PM_{2.5}$ was found to be at a high level (56.50%). This finding coincides with previous studies in different countries, such as Taiwan,[28] China,[29, 30] and Bangladesh,[31] which reported that most of the participants had a high level of self-protective behavior regarding $PM_{2.5}$. A study conducted in Myanmar[32] revealed that only 35% of the participants in Yangon and Mandalay had a high level. A study in the northeastern Thailand region[21] indicated that 45.7% of the elderly residing in Sakon Nakhon province exhibited a high level of self-protective behavior. Similarly, Chaiprapankoon et al[33] also confirmed a high level of self-protective behavior from 8 provinces in central Thailand. Several studies from Chon Buri,[34] Lop Buri,[35] and Pathum Thani Province[36] reported moderate self-protective behavior. The possible explanation for this scenario might be explained by multiple factors influencing awareness and response to the local air pollution problem. Chiang Rai province is classified as a

high-risk area for PM$_{2.5}$, which contributes to people exhibiting high self-protective behavior. Besides, Chen et al[37] highlight that self-protective behavior involves not only wearing facemasks but also considering factors such as mask type (eg, N95), exposure intensity, and the nature of the pollution. While masks provide some protection, they do not guarantee complete protection, especially when PM$_{2.5}$ levels are extremely high or when pollutants come from specific sources, such as wildfires. Furthermore, support from government agencies and local organizations for health education, health promotion, and public policy is considerable, particularly for vulnerable groups such as children, pregnant women, and the elderly.[38]

Access to Air Quality and Health Information About PM$_{2.5}$

The study found that most participants (58.30%) had high access to air quality and health information about PM$_{2.5}$, which was significantly associated with self-protective behavior. This result aligns with a previous study among community-dwelling Chinese people in China.[39, 40] It reports that accessing health information from social media, especially Weibo and WeChat, was associated with their health perceptions and behaviors. Several studies in Thailand by Nakaruk et al,[34] Wongarsa et al[27], and Chansri et al[41] revealed that a high level of access to information was associated with self-protective behavior. Furthermore, social media, including Facebook, as well as television/radio, and official websites, were common sources of PM$_{2.5}$ information. A study by Tassana-iem[21] also supports the notion that health information from public healthcare officials was a key determinant of access to health information among older adults in Sakon Nakhon province. This finding may be explained by the idea that access to air quality and health information helps individuals become aware of the risks and health impacts of air pollution, make better decisions to protect their health, and plan their daily activities more effectively.[21, 39]

Attitude Toward PM$_{2.5}$

The findings of this study showed that most participants had a moderate attitude toward PM$_{2.5}$ (60.60%), and attitude was significantly associated with protective behavior. This finding coincides with the study conducted in Hong Kong by Woo et al,[42] which reported that the attitude toward PM$_{2.5}$ of parents with young children was associated with self-protective behavioral responses concerning exposure to air pollution. Several studies in South Korea[43] and China[39] also revealed that attitude was positively correlated with health-protective behavior during air pollution. This is supported by a systematic review,[20] which indicates that attitude was also a stronger predictor of intentions to adopt preventive measures toward PM$_{2.5}$ exposure. A possible explanation is that a positive attitude toward air pollution can influence individuals' intentions and decisions to act, particularly in terms of self-protection behavior. It can motivate participants to be more intentional and proactive in adopting protective measures.[43]

Age

In the present study, age was significantly positively correlated with self-protective behavior. This finding aligns with a previous study, which conducted an online survey of 1245 South Koreans and reported that age was positively correlated with self-protective intentions regarding air pollution.[43] This finding is supported by a study conducted in Thailand[44] that reported a correlation between age and preventive behavior among undergraduate students living under PM$_{2.5}$ dust conditions in the Dusit district, Bangkok.

Similarly, a study conducted by Nakaruk et al[34] indicates that participants aged 70-79 are more likely to have high self-protective behavior than those aged 60-69. In contrast, a study conducted in Sukhothai province by Santiniyom et al[45] reported that participants aged 18-29 years had a high level of preventive behavior. There is a possibility that increasing age also increases self-protective behavior, which may be owing to their life experiences, including taking care of themselves, protecting themselves, and avoiding high-risk behavior more than younger people. Moreover, some of the older participants might be facing a chronic disease, such as chronic obstructive pulmonary disease. Consequently, it influences them to have higher health concerns and adopt self-protective behavior.[34]

This study fills the gap in understanding the factors influencing self-protective behaviors during the $PM_{2.5}$ crisis in one of the high-density $PM_{2.5}$ areas. There are a few limitations of this study. First, the cross-sectional study design was limited in its ability to explain the causal relationships between the factors. Second, the study participants consisted of a small sample size and were from only one district; therefore, further studies should include a larger sample size and multiple districts to represent Chiang Rai province or the border area between Thailand, Myanmar, and Laos. Third, social desirability bias might be occurring in this study because of the interviewing methods that potentially influence participants to provide answers based on what they think is socially acceptable. Moreover, other factors, such as chronic diseases, the health belief model, and the theory of planned behavior, should be applied to better understand the factors that influence self-protective behavior.

Conclusions

Most participants had levels of high self-protective behavior (56.40%). Several factors contribute to self-protective behavior among dwelling communities, including age, attitude toward $PM_{2.5}$, and access to air quality and health information about $PM_{2.5}$. Public health interventions should enhance attitudes toward and access to air quality and health information regarding $PM_{2.5}$. In addition, tailored interventions specifically targeting at age-specific populations are recommended.

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