

Factors predicting self-protective behaviors against PM2.5 exposure among rural community-dwelling older adults in the Central Region of Thailand: A cross-sectional study

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Received: 9 September 2025 **Revised:** 19 November 2025 **Accepted:** 23 November 2025 **Available online:** September 2026
DOI: 10.55131/jphd/2026/240302

ABSTRACT

Health problems resulting from exposure to Particulate Matter 2.5 (PM2.5) have been increasing rapidly, especially among vulnerable groups such as older adults. This cross-sectional survey research aimed to examine the level of self-protective behaviors and the factors predicting such behaviors against PM2.5 exposure among 885 rural community-dwelling older adults in the central region of Thailand. The research instruments consisted of three parts: 1) a demographic questionnaire for older adults including related modifying factors; 2) a questionnaire assessing predictive factors based on the six-dimension Health Belief Model, including perceived risk of health problems, perceived severity of health problems, perceived benefits of self-protection, perceived barriers to self-protection, perceived self-efficacy, and perceived cues to action; and 3) a questionnaire on self-protective behaviors against PM2.5 exposure. The data were analyzed using descriptive statistics and stepwise multiple regression analysis.

The results revealed that the mean score for overall self-protective behaviors against PM2.5 exposure among Thai rural community-dwelling older adults was at a good level ($\mu = 2.23$, $\sigma = 0.61$). Factors based on the Health Belief Model, including age, perceived benefits of prevention, perceived barriers to prevention, perceived self-efficacy, and perceived cues to action, jointly predicted self-protective behaviors against PM2.5 exposure, accounting for 57.00% of the variance, with statistical significance at .05 ($R^2 = .570$, $p < .001$). Based on the findings, healthcare providers should incorporate these predictive factors when designing interventions aimed at modifying health behaviors to effectively prevent health problems and diseases caused by PM2.5 exposure among Thai rural community-dwelling older adults.

Keywords:

predictive factors, Health Belief Model, self-protective behaviors, Thai rural community-dwelling older adults

Citation:

Winthanyou Bunthan, Anchalee Ngamchantratip, Pirunlak Jitdorn, Jariyawat Kompayak. Factors predicting self-protective behaviors against PM2.5 exposure among rural community-dwelling older adults in the Central Region of Thailand: A cross-sectional study. J Public Hlth Dev. 2026;24(3):16-29 (<https://doi.org/10.55131/jphd/2026/240302>)

INTRODUCTION

The world is currently facing major health challenges due to air pollution, which contributes significantly to the global disease burden. Fine particulate matter with a diameter of 2.5 micrometers or less (PM_{2.5}) is increasingly recognized as one of the most serious environmental health hazards. Recent meta-analyses demonstrate that long-term exposure to PM_{2.5} is associated with elevated all-cause mortality (HR 1.08 per incremental exposure) and increased cardiovascular disease (CVD) incidence and mortality (HR 1.09 and HR 1.12, respectively) among large cohorts.¹ Moreover, PM_{2.5} exposure plays a key role in the development and progression of multiple conditions, including acute lower respiratory infections, chronic obstructive pulmonary disease (COPD), ischemic heart disease (IHD), lung cancer, stroke, and various neurological disorders.² This health crisis is particularly severe in low- and middle-income countries (LMICs) where infrastructural constraints, high population densities and fewer regulatory resources exacerbate exposure risks.³ Vulnerable populations within these contexts—especially older adults and individuals with pre-existing chronic conditions—are at heightened risk from PM_{2.5} exposure.⁴

PM_{2.5} originates from a variety of both natural and anthropogenic sources. In indoor environments, significant contributors include the use of polluting fuels in unvented heating and cooking stoves, tobacco smoking, and other forms of combustion. Outdoor sources of combustion include land, air, and water transportation; industrial activities and power generation; and biomass burning, such as controlled and uncontrolled forest fires, as well as the burning of agricultural and urban waste.⁴⁻⁵ Recent data from Southeast Asia indicate that only approximately 2.7% of monitored

cities complied with the World Health Organization (WHO) annual PM_{2.5} exposure guidelines in 2022, with industrial emissions, transportation, and open burning being the primary contributors to the pollutant mix. In Thailand, national air quality monitoring reports have shown that PM_{2.5} concentrations remain at alarming levels.⁶

Thailand is facing significant health risks from PM_{2.5} exposure. According to a 2022 survey, Thailand ranked 57th globally and 5th in Southeast Asia among countries with the worst air pollution from PM_{2.5}. In 2019, data showed that the number of deaths in Thailand attributable to PM_{2.5} pollution was 46 per 100,000 people, increasing to 85 per 100,000 people in 2021.⁷ In the fiscal year 2024, Thailand reported a total of 3,003,407 patients with diseases related to PM_{2.5} exposure, including COPD, acute asthma, acute coronary syndrome, conjunctivitis, and dermatitis.⁸ The highest incidence of diseases related to PM_{2.5} was found to occur from October 2023 to June 2024. This period corresponds to Thailand's winter season and the time when agricultural land preparation typically takes place, including forest and field burning activities.⁹

The health impacts associated with PM_{2.5} exposure are influenced by the duration of exposure and other factors such as age, pre-existing medical conditions, and individual health behaviors. Previous studies have found that women with higher levels of education and income, and those who obtain information from diverse media sources, tend to exhibit greater risk perception regarding PM_{2.5} exposure. This heightened awareness is associated with more protective behaviors such as staying indoors during high-pollution periods, reducing outdoor activities, using air purifiers, and wearing N95 masks.¹⁰ Older adults are particularly vulnerable to adverse

health outcomes compared to younger populations, especially those with chronic illnesses.² The role of nurses is to prevent and mitigate the negative effects of age-related changes, while promoting optimal health and functioning in older adults.¹¹

The Department of Health, Ministry of Public Health, Thailand, has issued guidelines for various risk groups. Older adults are advised to adopt protective behaviors such as wearing a mask or covering nose and mouth with cloth when going outside, avoiding smoking, and limiting outdoor activities. Additional recommendations include keeping doors and windows tightly closed, avoiding activities that generate dust, regularly checking PM2.5 levels, monitoring for unusual symptoms, planting trees to help trap dust, avoiding idling vehicle engines, turning off engines immediately after parking, washing hands and showering after dust exposure, consulting a doctor if unusual symptoms occur, using air purifiers, and cleaning indoor areas where dust tends to accumulate.¹² These behaviors are essential for preventing PM2.5 exposure, particularly among older individuals, to reduce the risk of developing exposure-related diseases.

PM2.5 levels that affect the health of older adults begin at 37.5 µg/m³ (AQI > 100), corresponding to the orange zone.¹³ The research area is a rural community located in a sub-district of a province ranked among the top 15 in Thailand for hazardous PM2.5 levels. This province falls within the red zone, with average PM2.5 concentrations ranging from 56 to 150 µg/m³ (AQI = 151–200) and above.¹⁴ The principal investigator identified three main causes of PM2.5 in the area: (1) proximity to Thailand's largest limestone and cement mining industry, (2) rice-based farming practices involving routine stubble burning for biannual cultivation, and (3) a large garbage pit prone to spontaneous and nearby waste burning. These three causes align with the WHO's identified sources of PM2.5 pollution⁴ and are believed to

contribute to the area's persistent air quality issues. During fiscal year 2024 (October 2023–September 2024), average PM2.5 concentrations in the study area consistently exceeded national standards¹⁵, corroborating data from the Pollution Control Department (2023)¹⁶ that reported levels at or above the orange zone, indicating air quality hazardous to both the general population and sensitive subgroups. According to the findings, pollution levels were highest during the winter season, which is consistent with studies conducted in Bangkok, Nonthaburi, and Samut Prakan, Thailand, reporting that health risks associated with PM2.5 exposure increase when influenced by meteorological factors.³ The community is predominantly agricultural, with routine post-harvest stubble burning and the absence of centralized waste management leading to household waste incineration, both of which substantially contribute to PM2.5 emissions. These practices have significant public health implications, as evidenced by 31.74% of the population being diagnosed with respiratory conditions attributable to PM2.5 exposure. This represents a high rate comparable to the national population-attributable fraction of deaths from lower respiratory infections (LRI) in Thailand reported at 48%, highlighting the considerable impact of ambient particulate matter on respiratory health.¹⁷ Older adults are disproportionately affected, with 19.00% of individuals aged 60 years and above requiring treatment for PM2.5-related illnesses. Therefore, this research area represents a setting where the older population is at significant risk of health problems due to exposure to PM2.5. These individuals must take strict precautions to protect themselves from both indoor and outdoor exposure to PM2.5.

Although several studies in Thailand have documented PM2.5 exposure and its associated health impacts, few have integrated data on risk perception, protective behaviors, and age-specific

vulnerabilities.^{10,18} A review of the existing literature reveals a lack of clear information regarding the health behaviors of older adults in this area related to PM2.5 protection. To effectively promote appropriate protective behaviors aimed at preventing illness or health complications from PM2.5 exposure, it is essential to understand the factors influencing such behaviors. Hence, this study aimed to examine the level of self-protective behaviors against PM2.5 exposure and identify the predictive factors of self-protective behaviors against PM2.5 exposure based on Health Belief Model (HBM) theory¹⁹ among Thai rural community-dwelling older adults. The application of the HBM in this research is of great significance, as it enabled the researchers to systematically understand the mechanisms underlying individual decision-making processes in adopting or avoiding health-related behaviors. Moreover, it helped explain variations in behaviors among individuals within diverse social and cultural contexts.²⁰ (Glanz, Rimer, & Viswanath, 2015) Therefore, the HBM served as an appropriate conceptual framework for the present study. The findings of this study can also serve as foundational evidence for developing a care model (care manager) or direct care interventions (direct care) for older individuals at risk of PM2.5-related health issues. These interventions will aim to prevent serious health conditions, by tailoring them to the rural community context and integrating them into the existing local health and social service systems.

METHODS

Study Design: This research employed a cross-sectional design and was reported in accordance with the Strengthening

the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

Population and Setting: The research area was a rural community located in a sub-district of a province ranked among the top 15 in Thailand for hazardous PM2.5 levels. This study was conducted among the entire 897 older adult population (aged 60 years and above) in the subdistrict who met the following inclusion criteria (purposive sampling): 1) residing in the research area for one year or more; 2) demonstrating normal level of cognitive function as assessed by the Mini-Cog; 3) ability to read and write in Thai; and 4) willingness to provide informed consent to participate in the study. The exclusion criteria were: 1) being bedridden; or 2) refusing to provide consent and 3) requesting to withdraw from the study during data collection. When the researcher developed the sampling frame of all older adults in the subdistrict based on civil registration data and verified the inclusion and exclusion criteria, it was found that a total of 885 older adults met the inclusion criteria, while 12 individuals were excluded.

Research Instruments: Four instruments were used in this study, including one screening tool and three questionnaires for data collection. Permission to use all instruments was obtained prior to data collection. Cronbach's alpha coefficients were assessed in a pilot test with 30 individuals who met the same inclusion criteria as the participants in the main study.

Screening Instrument:

The Mini-Cog assessment was used to evaluate the cognitive function of the older adult participants. It consists of two components: (1) word recall and (2) clock drawing. A score of less than 3 indicates impaired cognitive function.

Data Collection Instruments:

A demographic questionnaire with a set of modifying factors developed by the

principal investigator (PI) was used to collect information from older adults regarding gender, age, education level, marital status, financial status, underlying diseases, and medication history.

A *questionnaire assessing predictive factors* based on the HBM regarding self-protective behaviors against PM2.5 exposure included the following components: perceived risk of health problems, perceived severity of health problems, perceived benefits of self-protection, perceived barriers to self-protection, perceived self-efficacy, and cues to action. The questionnaire used a four-point rating scale: strongly agree (3 points), moderately agree (2 points), slightly agree (1 point), and disagree (0 points). Data interpretation was categorized into three levels, following Srisa-ard,²¹ with each level spanning a range of 1.00 point: low perception (0.00–1.00), moderate perception (1.01–2.00), and high perception (2.01–3.00). A sample question is, “*Do you believe that you can avoid exposure to cigarette smoke?*”

A *questionnaire on self-protective behaviors against PM2.5 exposure* included items such as drinking eight glasses of water daily, wearing a mask when outdoors, cleaning dust inside the house, washing after dust exposure, avoiding smoking and secondhand smoke, closing doors and windows, turning off car engines when not in use, seeing a doctor if symptoms arise after dust exposure, monitoring for symptoms, planting trees to trap dust, avoiding outdoor activities, refraining from burning in any area, and checking dust levels. The questionnaire used a four-point rating scale: regularly (3 points), mostly (2 points), sometimes (1 point), and never (0 points). Data interpretation was categorized into three levels based on Srisa-ard,²¹ with each level spanning a 1.00-point range: poor practice (0.00–1.00), moderate practice (1.01–2.00), and good practice (2.01–3.00). A sample

question is, “*Do you monitor PM2.5 levels?*”

The three questionnaires described above were reviewed for content validity by five experts: three nursing instructors specializing in community health nursing and two specializing in geriatric nursing. Content validity was assessed using the Index of Item-Objective Congruence (IOC), with all items receiving scores between 0.60 and 1.00. Reliability testing was conducted through a pilot study involving 30 older adults living in rural communities with similar lifestyles and PM2.5 exposure levels to those of the study sample. Cronbach’s alpha coefficients for the three questionnaires were calculated at .86, .81, and .86, respectively.

Data Collection: All participants provided written informed consent indicating willingness to participate in the study, and data were collected by the researchers between November 2024 and February 2025. However, although the data were collected from the entire population to eliminate selection bias, the potential for response bias remained. During the data collection process, the researcher thoroughly explained the study to the participants, emphasizing ethical principles, the benefits of the research findings, and the confidentiality of the information, which could not be linked to individual participants or affect access to any health or social services. Participants who were able to read and write completed the questionnaire independently. However, for those who could read and write but were not fully proficient, the researcher read each question aloud and recorded their responses as verbally provided.

Data Analysis: Descriptive analysis was conducted using frequency, percentage, range, mean and standard deviation. The researcher used multiple linear regression to analyze the predictability of the independent variables (gender, age, education, marital status, financial status, underlying diseases,

medication history, primary caregiver, perceived susceptibility, perceived severity, perceived benefits of self-protection, perceived barriers to self-protection, perceived self-efficacy and cues to action) over the dependent variable. Potential confounders were included in the regression model to control effects, and the fifth model of the stepwise approach was used. All assumptions were met, including linearity, homoscedasticity of the regression standardized residuals, absence of multicollinearity (Tolerance = .541-.995 nearly 1.00, VIF = 1.005-1.932 less than 10), except for perceived susceptibility and perceived severity, both of which showed high intercorrelations ($r > .80$)²², and normality of the standardized residuals for a large sample size ($N = 885$).²³ The IBM

SPSS statistical software was used for data analysis, with the significance level set at 0.05.

RESULTS

Most of the older adult participants were female (56.60%) with an average age of 70.82 years ($\sigma = 7.84$; range = 60.00–97.00 years). Most had a primary school education (80.60%), were living with a spouse or partner (64.00%), and reported having sufficient income to cover expenses (60.80%). In addition, 57.70% had underlying diseases, 55.60% regularly used medication, 68.80% had a caregiver, and 94.01% lacked access to an air purifier (Table 1).

Table 1. Demographic characteristics of the sample ($N = 885$)

Demographic Characteristics	Number	Percentage
Age (years) (Min = 60, Max = 97, Median = 70.82)		
Gender		
Male	384	43.40
Female	501	56.60
Education Level		
No Formal Education	12	1.50
Primary School Level	713	80.60
Secondary School Level	80	9.00
Bachelor's Degree Level	42	4.70
Higher Than Bachelor's Degree Level	2	0.20
Other	35	4.00
Marital Status		
Single	78	8.80
Widowed	226	25.60
Divorced/Separated	14	1.60
Married or Cohabiting	566	64.00
Financial Status		
Sufficient	538	60.80
Insufficient	347	39.20
Underlying Diseases		
Yes	511	57.70
No	374	42.30
Medication History		
Regular Use of Medication	492	55.60
No Regular Use of Medication	393	44.40
Primary Caregiver		
Yes	610	68.80

Demographic Characteristics	Number	Percentage
No	275	31.00
Access to An Air Filter		
Yes	53	5.99
No	832	94.01

Note. Min = Minimum, Max = Maximum

Table 2 shows the level of self-protective behaviors against PM2.5 exposure among Thai rural community-dwelling older adults. Overall, the average score for self-protective behaviors was 2.23 ($\sigma = 0.61$), indicating a good level. When analyzing each item, most preventive

behaviors were found to be at a good level, with average scores ranging from 1.75 to 2.59. However, two behaviors were identified at a moderate level: checking dust levels and seeing a doctor if symptoms arise after dust exposure.

Table 2. Level of self-protective behaviors against PM2.5 exposure among Thai rural community-dwelling older adults (N = 885)

Self-Protective Behaviors against PM2.5 Exposure among Thai Rural Community-Dwelling Older Adults	μ	σ	Behavior levels
1. Wearing a Mask When Outdoors	2.59	0.071	Good
2. Washing after Dust Exposure	2.52	0.725	Good
3. Cleaning Dust Inside the House	2.49	0.774	Good
4. Avoiding Smoking and Secondhand Smoke	2.45	0.914	Good
5. Drinking Eight Glasses of Water Daily	2.40	0.071	Good
6. Reminding Others to Turn Off Car Engines	2.33	0.897	Good
7. Keeping Doors and Windows Closed	2.25	0.847	Good
8. Monitoring for Symptoms after Dust Exposure	2.13	0.957	Good
9. Turning Off the Car Engine When Arriving Home	2.13	1.045	Good
10. Planting Trees to Trap Dust	2.12	0.931	Good
11. Refraining from Burning in Any Area	2.09	0.954	Good
12. Avoiding Outdoor Activities	2.06	0.928	Good
13. Seeing a Doctor for Symptoms after Dust Exposure	1.98	0.961	Moderate
14. Checking PM2.5 Dust Levels	1.75	1.091	Moderate
Overall Self-Protective Behaviors	2.23	0.61	Good

Multiple linear regression analysis using the fifth model of the stepwise method accounted for 57.00% of the variance in self-protective behaviors against PM2.5 exposure, as explained by all predictors ($R^2 = 0.570$). The inclusion of independent variables in the regression model required the exclusion of certain variables as follows: (1) perceived susceptibility and perceived severity, which exhibited high intercorrelations ($r > .80$) (Kim, 2016); and (2) gender, education, marital status, financial status, underlying

diseases, medication history, and primary caregiver, which showed low partial correlation values (.024–.094). The significant predictors of self-protective behavior among the Thai rural community-dwelling older adults were cues to action ($\beta = 0.429$, $p < 0.001$), followed by perceived benefits of self-protection ($\beta = 0.238$, $p < 0.001$), perceived self-efficacy ($\beta = 0.162$, $p < 0.001$), perceived barriers to self-protection ($\beta = 0.109$, $p < 0.001$) and age ($\beta = 0.067$, $p = 0.003$), respectively, as shown in Table 3.

Table 3. Multiple linear regression model predicting self-protective behavior against PM2.5 exposure among Thai rural community-dwelling older adults (N = 885)

Variables	B	S.E.	β	t	p-value	Collinearity Tolerance	VIF Statistic
(Constant)	-0.515	0.142	-	-3.627	< 0.001	-	-
Age	0.005	0.002	0.067	2.996	0.003	0.995	1.005
Perceived Benefits of Self-Protection	0.264	0.034	0.238	7.725	< 0.001	0.517	1.932
Perceived Barriers to Self-Protection	0.079	0.016	0.109	4.815	< 0.001	0.953	1.049
Perceived Self-Efficacy	0.173	0.032	0.162	5.391	< 0.001	0.548	1.824
Cues to Action	0.481	0.034	0.429	14.224	< 0.001	0.541	1.847

Note. B = unstandardized coefficient, β = standardized coefficient, $R = 0.755$, $R^2 = 0.570$, adjusted $R^2 = 0.567$, $F = 231.507$, $p < 0.001$.

DISCUSSION

1. The overall level of self-protective behaviors against PM2.5 exposure among the Thai rural community-dwelling older adult participants was found to be at a good level. When considering individual items, most self-protective behaviors were rated at a good level, except for two behaviors: checking PM2.5 levels and seeing a doctor for symptoms after dust exposure, both of which were rated at a moderate level. The above finding might have been due to the physical and technological limitations experienced by older adults, which can affect their ability to access health information from various sources. Information on PM2.5 levels and air quality is often available only through smartphone applications, which are perceived as new, complex, and challenging to use by older adults.

This finding suggests that older adults may experience barriers when using complex smartphone applications for air quality monitoring, thereby limiting access to critical information. This aligns with the HBM, which proposes that perceived barriers such as difficulties in accessing information due to technological

limitations or physical constraints can hinder individuals from engaging in preventive behaviors, even when a health threat is recognized.²⁴⁻²⁵

The good level of self-protective behavior observed in this study may also be attributed to the timing of data collection. During this period, air quality monitoring showed elevated levels of PM2.5 reaching red and orange levels (PM2.5 concentration $\geq 91 \mu\text{g}/\text{m}^3$, indicating a significant public health risk), and even purple on some days (PM2.5 levels exceeding $150\text{--}200 \mu\text{g}/\text{m}^3$ are classified as "hazardous" or posing "severe health impacts"). These levels were more severe than those recorded during the same period in the previous year. Moreover, continuous burning at a nearby landfill contributed to the elevated pollution levels. In response, staff from the Subdistrict Health Promoting Hospital actively disseminated information on protective measures against PM2.5 exposure.

These factors likely contributed to the adoption of good self-protective behaviors among the older adult participants, which is consistent with the Health Belief Model's (HBM) concept of "cues to action." The visibly high pollution levels, public health campaigns, and

severity of the situation served as strong external cues increasing both the perceived severity of the threat and the perceived benefits of taking action. This finding aligns with a previous study reporting that preventive behaviors against fine particulate matter among elderly individuals in high-risk areas were at high (51.7%) and moderate levels (48.3%).²⁶ In contrast, a study conducted by Koteprom et al. (2024) found poor PM2.5 protective behaviors among older adults living in areas affected by transboundary pollution (Mean = 1.83, SD = 0.98).²⁷ This discrepancy may be due to the nature of PM2.5 exposure in different regions. In the latter case, pollution tends to occur gradually and may not cause immediate severe effects, leading to reduced interest in and awareness of health protection among older adults.

2. Factors capable of predicting self-protective behaviors against PM2.5 exposure among the Thai rural community-dwelling older adults in the present study included:

Age: Due to the advanced age of the sample group, delayed access to information—particularly from electronic media—and limited physical mobility may have contributed to poorer self-protective behaviors against PM2.5 exposure. This contrasts with younger individuals, who are generally able to access news more quickly and learn more effectively, leading to better preventive behaviors. This finding is consistent with studies conducted by Malaicharoen et al. (2022) and Muneet et al. (2024), both of which reported a statistically significant relationship between age and self-protective behavior against PM2.5 at the 0.05 level.²⁸⁻²⁹ Further supporting the influence of age, a study on factors associated with COVID-19 preventive behaviors among elderly patients with diabetes also identified age as a predictive factor for such behaviors.³⁰

Perceived Benefits of Self-Protection: When older adults hold beliefs

about the positive outcomes of engaging in self-protective measures against PM2.5 exposure such as recognizing the severity and potential health impacts of PM2.5, they are more likely to perceive the benefits of behaviors that help prevent or reduce the risk of disease.³¹ This finding is consistent with existing studies on older adults with chronic conditions such as hypertension, diabetes, coronary artery disease, and stroke, suggesting that a strong perception of the benefits of health-related behaviors is associated with the adoption of appropriate self-care practices. Such behaviors may include, for example, adherence to prescribed antihypertensive medication and dietary modifications to prevent complications related to diabetes and hypertension.³²⁻³⁵ Previous studies have shown that the perceived benefits factor can predict behavioral intention for dementia prevention.³⁶

Perceived Barriers to Self-Protection: Older adults often hold preconceived notions and beliefs about the challenges and barriers associated with practicing self-protective behaviors against PM2.5 exposure. For example, wearing a mask or using cloth to cover the nose and mouth when going outdoors may pose difficulties for older individuals, particularly those with underlying conditions such as heart disease, respiratory disease, asthma, or hypertension. These individuals may experience breathing difficulties, as the heart and lungs are required to work harder. Additionally, the increased cost of purchasing face masks can be another significant obstacle to engaging in self-protective behaviors. This aligns with the Health Belief Model, which posits that individuals are more likely to adopt health-promoting behaviors when perceived barriers are low.³⁷ Supporting this view, a previous study on the factors associated with preventive behaviors against COVID-19 among patients with chronic illnesses identified perceived barriers as a key influencing factor.³⁸

Specifically, individuals who perceived greater obstacles were less likely to engage in preventive behaviors, whereas those who perceived fewer barriers demonstrated higher levels of protective action. Previous studies have shown that the perceived barriers factor can predict behavioral intention for dementia prevention.³⁶

Perceived Self-Efficacy: When older adults have confidence in their ability to engage in self-protective behaviors against PM2.5 exposure, it often leads to positive behavioral outcomes. A previous study conducted among a Korean population found that self-efficacy was the strongest predictor of the intention to protect oneself from air pollution.³⁹ Similarly, it has been reported that older adults in Thai communities demonstrated a high level of perceived self-efficacy, which emerged as the most significant predictor of self-protective behaviors against PM2.5 exposure when compared to other predictive factors.⁴⁰ Previous studies have shown that the perceived self-efficacy factor can predict behavioral intention for dementia prevention.³⁶

Perceived Cues to Action: Older adults are often exposed to situations or triggers that prompt them to engage in behaviors aimed at preventing health problems related to PM2.5 exposure. For example, they may recognize unsafe environmental conditions that could lead to health issues if preventive measures are not taken. The perception of the severity of health consequences plays a key role in influencing individuals' willingness to comply with government policies and adopt various preventive measures.⁴¹ Similarly, increased exposure to information about the COVID-19 pandemic through various media platforms has been linked to higher rates of COVID-19 vaccine uptake.⁴² This is consistent with findings by Weerawongsawat et al. (2021), which showed that cues to action significantly

predicted adherence to prescribed antihypertensive medication among older adults.³² These findings underscore the critical role of effective health communication strategies. Both governmental and private health sectors should prioritize the dissemination of clear and accessible information regarding the risks of PM2.5 exposure. Doing so may help promote the adoption of preventive behaviors and reduce adverse health outcomes among vulnerable populations in both the short and long term.

The factors outlined above can be used as predictive factors for health behaviors aimed at self-protection from PM2.5 exposure among older adults. These behaviors include wearing protective masks or cloth covering the nose while stepping outside the house, drinking enough pure water, quitting smoking or avoiding secondhand smoke exposure, avoiding outdoor activities, keeping the doors and windows of the house closed tightly, avoiding activities that generate dust, incorporating dust-trapping plants within the house, utilizing air purifiers, monitoring PM2.5 level data, and remaining vigilant for any unusual physical symptoms. This was consistent with the study conducted by Nomsiri et al. (2024), which found that perceived barriers to self-protection, perceived benefits of self-protection, and perceived self-efficacy in preventive behaviors were positively correlated with self-protective behaviors against PM2.5 exposure among elderly people in high-risk areas.²⁶

LIMITATIONS OF THE STUDY

This study was conducted in a single rural subdistrict, which may limit the generalizability of the findings to urban or semi-urban communities. Moreover, because the data were collected from the entire population, probability sampling was

not applied; participants were included based solely on the specified inclusion and exclusion criteria. Another limitation was that some participants had limited reading and writing abilities, which affected their ability to complete the questionnaire independently. To mitigate this issue, the researcher read each question aloud and recorded the participants' verbal responses.

CONCLUSIONS AND RECOMMENDATIONS

This study found that age, perceived benefits of prevention, perceived barriers to prevention, perceived self-efficacy, and perceived cues to action were significant predictors of self-protective behaviors against PM2.5 exposure among the Thai rural community-dwelling older adult participants. The findings highlight the important role of nurses in promoting self-protective behaviors among older adults. Nurses should implement strategies that enhance perceptions of the benefits of self-protection, reduce perceived barriers, strengthen self-efficacy, and increase responsiveness to cues to action in order to encourage more consistent self-protective behaviors. Additionally, nurses need to establish collaboration among public health personnel, local administrative organizations, and family members of older adults who are unable to check daily PM2.5 information or receive daily alerts through public media such as village broadcast towers or community radio. This collaboration should also involve providing adequate education on warning signs that require immediate medical attention or prompt consultation with public health officials after PM2.5 exposure. To develop programs or interventions that align with the lifestyles, beliefs, and needs of older adults, future research should include qualitative studies that explore in-depth the positive and negative behaviors in which older adults engage for protection against PM2.5 exposure. Furthermore, to improve

protective behaviors through the application of diverse perception-based frameworks, quasi-experimental studies should be conducted among older adults in other regions of Thailand facing different PM2.5 exposure contexts.

AUTHORS' CONTRIBUTIONS

WB: Methodology, Formal analysis, Investigation and Writing - Review & Editing. AN: Data Curation. PJ: Formal analysis, Writing - Original Draft and Writing - Review & Editing. JK: Methodology and Supervision.

ETHICAL CONSIDERATION

The research study was approved in accordance with the Declaration of Helsinki by the Human Research Ethics Committee of Huachiew Chalermprakiet University (Certification No. HCU-EC1457/2567) on March 4, 2024. All participants received a participant information sheet and provided written informed consent.

ACKNOWLEDGMENTS

We would like to thank the participants and all those involved in this research and express our sincere gratitude to Huachiew Chalermprakiet University for providing research funding support.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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